

Report

Secondary Agriculture

Value Addition to Primary Agriculture

*Submitted to the Planning
Commission of India*

Prof. DPS Verma



2008

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Secondary Agriculture: *Value Addition to Primary Agriculture*

-bridging the gap between the rural and urban economies of India-

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Technical Advisory Committee on Secondary Agriculture (TACSA) Report

Submitted to the Planning Commission, Government of India

(October 15, 2008)

Secondary Agriculture

- Adds value
- Creates jobs
- Reduces pollution
- Uses agro resources
- Improves farm economy
- Builds rural agro industries
- Increases international trade
- Adds quality to the life of rural India
- Makes agriculture internationally competitive

The world needs agro-based products.....

----India can deliver!



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ABBREVIATIONS

A			
ACAS	Additional Central Assistance Scheme	CSIR	Council for Scientific and Industrial Research
ADM	Archer Daniels Midland	CSIRO	Commonwealth Scientific and Industrial Research Organization
AERC	Agro Economic Research Centers	CSO	Central Statistical Organization
AEZs	Agri-Export Zones	D	
AIMLEA	All India Meat & Livestock Exporters Association	DAC	Department of Agriculture and Cooperation
AIR	All India Radio	DAHDF	Department of Animal Husbandry Dairying and Fisheries
APEDA	Agriculture and Processed Foods Export Development Authority	DARE	Department of Agricultural Research and Education
APMC Act	Agriculture Produce Marketing Committees Act	DBT	Department of Biotechnology
APSRAC	A.P. State Remote Sensing Applications Centre	DCP	Dicalcium phosphate
B		DEPB	Duty Entitlement Pass Book
BCP	Bicalphos	DGFT	Director General of Foreign Trade
BM	Blood Meal	DOE	Department of Energy
BPL	Below Poverty Line	DPR	Detailed Project Report
BSE	Bolster Safeguards against Bovine Spongiform Encephalopathy	E	
BTU	British Thermal Unit	EOU	Export Oriented Units
C		ESCOP	Experiment Station committee on Organization and Policy
CACP	Commission for Agricultural Costs and Prices	F	
CCI	Cotton Corporation of India	3F	Federated Farmers Farm
CDFD	Center for DNA Fingerprinting and Diagnostics	FAO	Food and Agriculture Organization
CET	Central Excise Tax	FAS	Financial Assistance Scheme
CFTRI	Central Food Technological Research Institute	FCI	Food Corporation of India
CIAE	Central Institute of Agricultural Engineering	FDA	Food and Drug Administration
CIMAP	Central Institute of Medicinal and Aromatic Plants	FDI	Foreign Direct Investment
CIS	Commonwealth of Independent States	FFA	Federation of Farmers Association
CMA	Centre for Management in Agriculture	FFSF	Full Fat Soy Flour
COSA	Central Office of Secondary Agriculture	FICCI	Federation of Indian Chambers of Commerce and Industry
		FM	Fish Meal
		FRLHT	Foundation for Revitalization of Local Health Traditions
		G	
		GAIF	Global Agro-Industries Forum
		GDP	Gross Domestic Product
		GM	Genetically Modified

GMP	Good Manufacturing Practice	MIS	Industry
GPS	Global Positioning System	MM	Market Intervention Scheme
H		MMPs	Meat Meal
HACCP	Hazard Analysis and Critical Control Point	MOFP	Multi-purpose Medicinal Plants
HFCS	High Fructose Corn Syrup	MPCAs	Ministry of Food Processing Industries
HFM	Hydrolyzed Feather Meal	MPCC	Medicinal Plant Conservation Areas
I		MSP	Medicinal Plants Conservation Centre
IASRI	Indian Agricultural Statistics Research Institute		Minimum Support Price
N			
IBTI	Integrated Bioprocessing Technology Institute	NABARD	National Bank for Agriculture and Rural Development
ICAR	Indian Council of Agriculture research	NAFED	National Agriculture Cooperative Marketing Federation
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics	NARS	National Agriculture Research System
ICTs	Information and Communication Technologies	NASULGC	National Association of State Universities and Land-Grant Colleges
IEA	International Energy Agency	NCCT	National Council for Cooperative Training
IFFCO	Indian Farmers Fertilizer Co-operative Ltd.	NCDC	National Cooperative Development Corporation
IFFDC	Indian Farm Forestry Development Co-operative Ltd.	NCL	National Chemical Laboratory
IHBT	Institute of Himachal Biodiversity Technology	NCUI	National Cooperative Union of India
IMPGC	Indian Medicinal Plant Growers Consortium	NIAM	National Institute of Ayurvedic Medicine
IMPGC	International Medicinal Plants Grower Consortium	NPOP	National Program of Organic Products
INESA	International and National Experts in Secondary Agriculture	NRCMAP	National Research Centre for Medicinal and Aromatic Plants
ISRO	Indian Space Research Organization	NRCS	National Research Centre for Sorghum
ISSC-MAP	International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants	NRCS	National Research Centre for Soybean
ITGI	IFFCO-TOKIO General insurance	NRI	Non Resident Indian
IUCN	International Union for Conservation of Nature	NYDC	New York State Department of Environmental Conservation
K			O
KBBE	Knowledge-Based Bio-Economy	OECD	Organization for Economic Co-operation and Development
KHET	Knowledge Hub for Entrepreneurship and Technology Information	OFPPC	On-Farm Primary-Processing Centers
KVK	Krishi Vigyan Kendra		P
L		PFFCS	Primary Farm Forestry Co-operative Societies
LFD	Local Final Demand	PLDCS	Primary Livelihood Development Cooperative Societies
LMCs	Local Management and Protection Committees	PM	Poultry Meal
M		PMA	Project Management Agencies
MAP	Medicinal and Aromatic Plants	PSS	Price Support Scheme
MAPCO	Medicinal and Aromatic Plants Certification Office		R
MBM	Meat Bone Meal	R&D	Research and Development
MFPI	Ministry of Food Processing	RIDF	Rural Infrastructure Development Fund

RISC	Rural Infrastructure & Services Commons	TIFAC	Research Institute Technology Information, Forecasting and Assessment Council
RKVY	Rashtrya Krishi Vikas Yojana	TRAFFIC	Wildlife Trade Monitoring Network
ROSA	Regional Offices of Secondary Agriculture	TSP	Textured Soybean Protein
RSVY	Rashtriya Sam Vikas Yojana		
S		U	
SAI	Secondary Agriculture Improvement	UNDP	United Nations Development Program
SAIF	Secondary Agriculture Innovation Fund Ltd.	UNIDO	United Nations Industrial Development Organization
SCFE	Super Critical Fluid Extraction	USAID	United States Agency for International Development
SEZs	Special Economic Zones	USDA	United States Department of Agriculture
SFFCS	State Farm Forestry Co-operative Societies	USPTO	United States Patent and Trademark Office
SHGs	Self-help Groups		
SION	Standard Input Output Norms		
SPS	Sanitary and Phytosanitary Standards		
SPUC	Soybean Processing and Utilization Centre	VAT	Value Added Tax
SPV	Special Purpose Vehicle	VKGUY	Vishesh Krishi Gram Udhog Yojna
T		W	
TACSA	Technical Advisory Committee for Secondary Agriculture	WWF	World Wildlife Fund
TBGRI	Tropical Botanical Garden and		

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PREFACE

India is going through a economic and social transformation. In this process the country has to transit from an agriculture-based economy to a products-and-services-based economy, and eventually move towards a knowledge-based economy. This path, however, is difficult to travel and requires a road map, which must be based on the acknowledgment of the fact that agriculture is the foundation of Indian economy. Since 65-70% population depends on this resource and they live in rural areas where there are not even basic necessities available, rural infrastructure improvement is the first challenge that the nation must face by providing power and connectivity to each village. Building industries based on the agriculture bioresource can only be done in a clustered manner so that such industries can be supported by input of raw materials and trained manpower along with other necessary infrastructure such as schools, police, hospitals etc., as China has accomplished. Creating these “centers of activity” and further connecting them to each village would allow a conduit for farmers to transport and have their agriculture products processed, and thus add value to the primary commodity and become an active player in building value-added secondary agriculture.

This reality, faced with declining agriculture productivity, is further widening the gap between the rural and urban population as was evident from the recent GDP report. The Technical Advisory Committee for Secondary Agriculture (TACSA) analyzed various other constraints, technical and regulatory as well as financial, along with various opportunities that this sector is presenting, and made a number of recommendations to jump-start this much-needed sector of the Indian economy.

This report addresses three key issues:

- 1. Farm structure to allow increased inputs for gain in productivity.**
- 2. Integrated technologies for developing secondary agriculture**
- 3. Financial vehicle(s) to jump-start the agro-based industries**

It is well demonstrated that secondary agriculture can add two to three fold value to the primary agriculture and thus can invigorate not only the rural economy but also urban economy as the capacity of rural people to absorb goods and services increases. A failure to act upon this opportunity, i.e., to build secondary agriculture Industries may have major social and political consequences as farmers have no other option available to them at this time. Similar to other areas, such as telecommunication, IT, Pharma etc., many of the needed technologies might have to be imported and adapted according to the needs of the industries, in addition to restructuring our R&D institutes to focus on the needs of the agriculture-based industries. Agriculture cannot be left to the farmer struggling with limited resources, as it is an industry that needs to compete in the open economy. Hence, all necessary help needs to be accorded to the farmer, from technology to financing to eventual marketing of the farm produce.

The fact that farm size itself has dwindled to below a level that can provide subsistence to a farmer, is a matter of serious concern. This slimitation can be partly overcome by consolidating farms to a size that allows necessary inputs to increase productivity. A mechanism is suggested here to address this important issue, where the farm boundaries can be maintained by remote sensing technologies, but abolished physically to achieve economy of scale. Finally, while outlining various opportunities that exist in different areas, a mechanism is provided by which the Government can act as Venture Fund to build

this sector on a business model, since many current subsidy schemes are not proving effective in the agriculture sector and the productivity continues to decline.

To build world-class agro industries, many of the needed technologies might have to be imported and adapted according to the Indian environment. For this a new and unique institutional structure is proposed: to build an Integrated Bioprocessing Technology Institute (IBTI). Such an institute would work closely with bioprocessing industries and address all issues of new product development from farm input to marketing.

Finally, suggestions are made to completely deregulate the agriculture industry except with regard to food safety. This is essential to provide necessary technological and financial inputs. The farmer should be completely free to grow, process, transport and sell any farm produce anywhere in the country, to take full advantage of and become participatory in the open economy of the country.

While more work may be needed to build detailed plans, this report provides a foundation for building secondary agriculture industries across the country in a clustered manner to empower farmers to receive maximum value for their commodities. Without such an effort the poverty level will continue to increase in the villages and the gap between the rural and urban population will further widen. The migration from rural to urban centers in search of employment, which is expected to increase significantly will create more slums in cities, as there are not enough jobs available in urban areas to absorb this influx of rural population projected in the Planning Commission report "Vision 2020".

Following a presentation in January 2006, a Technical Advisory Committee on Secondary Agriculture (TACSA) was constituted by the Planning Commission as per the DO No. M-12043/3/2006-Agri/DCH/11/06/2985 dated 9.2.2006 (Order received on May 2007). TACSA addressed various constraints, opportunities and potential for building world-class secondary agriculture industries in India and examined 5Ws (What, Why, Who, When and Where) as well as making attempts at "How" with a few examples. TACSA consisted of knowledgeable industrialists/scientists from India and NRIs from USA and Canada, along with key consultants, chaired by Prof. Verma, an internationally recognized plant biotechnologist who understands the Indian farmer's condition

and has the knowledge of the cutting-edge technologies that can transform the Indian agriculture.

The objective of the committee was to study thoroughly the current state of activities in secondary agriculture in India and to compare it with the developed countries to bring about the transfer of needed technologies, possible collaborations and facilitating setup of new industries, with the funding from government and private sectors, in each of the key areas. In addition, TACSA identified several key infrastructural needs for growth of the secondary agriculture industry in the country, and suggested a few solutions, including changes in the current government regulatory structure to facilitate rapid growth in this sector. It is believed that success in this undertaking would have a wide impact on the rural as well as urban economies and will help bridge the gap between these two communities that is otherwise widening. No doubt, this undertaking will be expensive, but the cost of not doing may prove higher than doing it at this stage, for which there is no alternative solution in sight.

TACSA:

1. thoroughly analyzed each sector that secondary agriculture is most likely to affect;
2. identified the current level of activities in each of these sectors in India;
3. evaluated the quality and value of many secondary agriculture products currently made in each sector in comparison with the international demands;
4. evaluated current technologies being used by Indian industries;
5. suggested some technology solutions available to improve current industries and help set up new world-class industries in each sector;
6. identified potential financial solutions and the willingness of key states to foster such development by implementing one or two model industries in each area;
7. identified impediments to launching a given industry in particular area in India.
8. evaluated the cost of solving the problem in each sector and the cost of not doing so
9. evaluated the impact of few such industries on Indian economy in the next 10-15 years.
10. estimated the level of activity (jobs) created by such industries.

11. evaluated the impact of the secondary agriculture revolution on rural economic development.
12. suggested a vehicle to implement proposed changes both at the government level and at the rural level where such industries must be located.

highly dedicated and passionate team of people who believe in this issue. It gives me a great pleasure to respectfully submit this report to Honorable Dr. M. S. Ahluwalia on behalf of TACSA for their consideration of various points suggested in this reports.

It was a privilege and an honor to serve the country in this capacity, and to work with a

Prof. D. P. S. Verma, FRSC
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It has been my privilege and great honor to serve as Chairman of the Technical Advisory Committee on Secondary Agriculture (TACSA) that was organized on the request of the Planning Commission of India. I would like to sincerely thank Honorable Dr. M. S. Ahluwalia (Deputy Chairman) and Dr. V. L. Chopra (Member of the Planning Commission) who believe in this issue and are keen to find a workable solution to this complex problem facing the nation. My thanks go to other members of the Planning Commission who attended various meetings of the Committee and made some suggestions. In particular the Committee is thankful for inputs received from representatives of various States during their visits to Punjab, UP, Kerala, Maharashtra, Uttarakhand and Orissa. In addition, many presentations made by different people/organizations during the Farmers Interface, Industry-Scientists Interface and the National Workshop on Jatropa and the presentations made at the Planning Commission are highly appreciated. In particular the discussions held with Dr. Mangala Rai, Secretary and Director General ICAR; Dr. P. K. Mishra, Secretary of Agriculture, Dr. M. K. Bhan, Secretary DBT and Dr. Brahmachari, Secretary and Director General CSIR, are highly

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1

EXECUTIVE SUMMARY

Agriculture is the foundation of Indian economy on which almost 70% of the population depends. Having achieved near self sufficiency in primary agriculture (grains, sugarcane, fruits, vegetable and milk, etc.), the country must now focus attention on “secondary agriculture” and add value to the basic agro-commodities to allow farmers to get better returns from their harvest, create new jobs in the rural sector to grow rural economy which is entirely based on agriculture. The share of agriculture in the national GDP is continuously declined in the last 10 years (from 31% to 18.34% at present) while the number of people depending on it remains the same. Secondary agriculture can reverse this trend and add two to three-fold value to primary agriculture. Examples of secondary agriculture include vitamins from grains, oil from rice bran, starched sugar from corn, milk and protein from soybean, industrial chemicals and biofuel from sugarcane and ligno-cellulosic biomass, fiber boards from rice straw, high-value animal byproducts, in addition to the well-known medicinal plants and herbal products not yet fully capitalized in India.

At present, the value added by the food processing industry is extremely low (about 8% of the total food production). Only 2.2% of horticulture products are processed, while more than 35% of fruits and vegetables are wasted due to lack of storage and processing facilities, and few secondary products (both food and non-food) are derived from plants or animals. Therefore, a significant opportunity exists for India if the primary agriculture could be transformed into secondary agriculture using appropriate technologies and building the needed rural infrastructure. Such a transformation would act as a catalyst to the entire GDP, as it would empower the farmer to take part in the open economy. Moreover, the rural population will become a better consumer

for other products and services, as it is happening in China and other Asian countries.

If agriculture is treated as an industry, then the question has to be asked: how to create value, deliver value and finally capture value: the basics of any business. Major constraints in building agro-industries in India include:

- Lack of coordination between the R&D institutes (ICAR, CSIR and DBT) and the agro-industries;
- Restricted flow of agricultural produce from one state to another;
- Poor market linkages for processed products for getting the price advantage;
- Lack of sufficient credit availability, administrative encouragement, policy support, etc.;
- Almost non-existent agri-venture capital in the country;
- Most important, the poor infrastructure -- essentially, the roads and transport systems to provide connectivity with urban markets, and the lack of power for cold storage systems and processing of perishable products.

Secondary agriculture is highly complex, as it involves old as well as new technologies, capital investments, improvements in rural infrastructure, marketing and some critical changes in Government regulations. If successfully implemented, however, this activity can add hundreds of billions of dollars to the Indian economy and create millions of new jobs within the next decade, making a fundamental change in rural life, which has so far not occurred in any significant way over the last 60 years. This “secondary agriculture revolution,” is in fact what Gandhi ji wanted--“Gramine Udhog Badhao”.

India has a large number of institutes in ICAR and CSIR systems that should have long been successful in bringing about this transformation, but due to the lack of coordination and a fragmented approach without direct interaction with industries, no substantial progress has been made with the exception of a few developments. The simple fact that **“Research is Business”** is not fully understood and realized, although some efforts are being made by CSIR to generate industrial links, while the same needs to be followed by ICAR and DBT institutes. All R&D activities at the national institutes must be driven by the needs of the industries, and the commodity-based ICAR institutes, such as Potato, Sugar Cane, Rice, Jute research Institute etc. need to consider, in addition to crop productivity, value-addition to each commodity as their primary objective in direct collaboration with the industries. Such value addition includes: improving farm productivity by novel inputs and developing new agro-based products. For example, a close co-operation between the four major institutes with primary focus on medicinal plants along with the Medicinal Plants Board should allow rescue of over two dozen endangered medicinal plants species and provide genomic and chemical fingerprints to validate plant materials for export. This will directly stimulate export of medicinal plants of which India deserves a better share than it currently has in this \$70 billion/year global industry.

Agro-commodity-based high-end processing industries in India are at an embryonic stage of development. It is capital intensive and highly competitive. The market capitalization of the key global players runs into several Billion (B) dollars each (ConAgra \$12B, ADM \$29B, General Mills/Pillsbury \$19B, Nestle/Purina \$177B, Corn Products International \$3B). Hence, the entry barriers to this industry are extremely high and help from the Government is needed. The industry normally operates on four basic business principles: value creation, value protection, value sharing and value recovery. It is important to keep in mind that even in developed countries where value addition is the norm, the spread between what the producers get and what the consumer pays goes down percent wise. The processor benefits, the retailers, wholesalers and consumers benefit as well as the middleman, but the producer gets the least benefit. We need to make sure that the same does not happen in India.

Indian self-sufficiency in agriculture may be short lived – India needs to approach the next twenty years differently from the way it has

approached the past. As Indian economy improves, there will be greater demand for not only the basic foods but also processed and more nutritious foods – adding value. Retail and infrastructure chain establishments demand fresh and high quality food without microbial and chemical contaminants and toxicants and agro-based non-food products. At the same time the country will have to increase competitiveness in global trade providing consistently high quality products and at a scale that will ensure meeting customers’ demands. The notion that the country should give up on increasing agriculture productivity is not right – this could be picked up by the private sector in profitable crops and the Government can focus on poor peoples’ crops and orphan crops while helping to build secondary agriculture industries.

The lack of incentives for the organized sector to participate; lack of infrastructure to grade, store, process and transport fruits and vegetable during the peak production season; and lack of organization of farming communities to go beyond selling their primary product are among some of the key reasons, aside from the availability of funds, why secondary agriculture is not developing in India as rapidly as it is needed.

The Technical Advisory Committee on Secondary Agriculture (TACSA) was constituted by the Planning Commission to address these issues and find workable solutions that can serve as catalysts to fuel private sector activities in this important area. Such a stimulus may help transform the Indian agriculture economy from the grass roots level, so that it can keep up at least with the average growth of the GDP. TACSA consisted of a team of national and international experts in different sectors of agriculture technologies under the Chairmanship of Prof. Verma from The Ohio State University, USA. Having roots in a village in UP and able to reach to heights of leading agriculture biotechnologists in the World, Prof. Verma is familiar with the dynamics of technologies and the reality of agriculture in India.

TACSA or a sub-set of it had extensive direct and indirect interactions during the last one-year (2008) with over 500 people, ranging from farmers to industrialists and scientists in India and abroad. Some TACSA members visited several States (Kerala, Maharashtra, Orissa-including a tribal area, Punjab, UP and Uttarakhand); hosted 3 one-day meetings with farmers, industrialists and scientists, as well as arranged a workshop on *Jatropha* to evaluate the potential of this crop for biofuel. This was followed by three extensive meetings (3 to 4

days each) at the Planning Commission to discuss various issues and to have further direct inputs from various Ministries and organizations (Agriculture, ICAR, DBT, Food Processing, Fisheries, Medicinal Plants Board), Meat Processors and ISRO for crop mapping data.

This report, consisting of 200 pages of direct comments on various issues supported by more than 100 pages of Appendix material and another 500 pages of data located on an interactive Web platform (www.secondaryagriculture.org), provides a glimpse of this complex issue which may need further evaluation of each sector in context with existing industrial activities in primary and secondary processing. This secured and interactive database needs to be further expanded to cover all sub-sectors and industries associated with agriculture to make it more comprehensive for providing a complete road map to judiciously build world-class secondary agriculture industries in India.

Analysis of this extensive task suggests that the potential for India in this area is enormous as it involves a wide sector of the agro-based economy. The range of products that can be, and should be, derived from primary agriculture is indeed very large. This includes by-products from grains, sugarcane, fruits, coconuts, medicinal plants, animals, and marine and other bioresource. Some activities do exist in these areas, but the level of these activities is very limited (less than \$2 Billion/year). Most of the technologies in use are primitive, and are focused on commodity products. Moreover, the scale of the operation is too small to make it difficult to compete with other Asian countries, let alone the West. This report focuses on three aspects:

1. **Farm structure and the inputs in primary agriculture, which is limiting productivity.**
2. **Technological, institutional and other infrastructural issues hampering building of world-class agro industries.**
3. **Financial vehicles able to drive such agro-based rural industries.**

Primary and secondary agriculture are interlinked. To increase the inputs for bioprocessing, a consolidated farm structure, Federated Farmers Farms (3F) system is proposed. It will allow the necessary inputs for enhancing primary agriculture to feed the secondary agro-bioprocessing industries, located in close proximity to such consolidated

farms. This system can start from contract farming in AEZs and eventually evolve into an integrated industry. For that, technologies available with ISRO can help to retain the original land boundaries on paper and electronically while abolishing them in practice, an act that will create more land and allow appropriate inputs for large-scale propagation and processing. The farmer will not only receive money for his/her land lease to 3F, but would be able to work on such farms and share a portion of the equity in the 3F Corporations. This model is based on several successful co-operative ventures both in India and abroad. This is the only way farm productivity can increase so that bulk processing can take place, as it will meet the necessary input requirements of the industry.

India has sufficient expertise in building successful cooperatives and can formulate a win-win policy for such organizations, taking into consideration both the farmer's and the investor's interests in such ventures. The farmer must retain the ownership of the land at all times. The details for implementing such a system need to be worked out by each state under a well-defined Central scheme. Indian legal structures are not yet conducive for this new paradigm shift in consolidated farming, however. It needs a major overhauling in the legal framework dealing not only with land but also markets, including the Agriculture Produce Marketing Committee (APMC) Act, Essential Commodities Act, and various taxes and restrictions on processing and retailing. Unless these bottlenecks are eliminated, major private sector investments in agri-business will remain difficult to attract and sustain. Consequently, the growth in high-value agriculture will remain a hostage to high risks associated with any new undertaking.

Extensive efforts are underway in Europe and North America to convert current chemical industrial processes to bio-based ones demanding more agro-inputs. This global transformation of agriculture is likely to open new opportunities for India to compete in these emerging areas, provided appropriate technologies and investments are available to build this sector. Agro-processing, byproduct utilization and biofuel production were identified as mutual areas of interest in the US/India Knowledge Initiative proposal.

This undertaking may be expensive, but the cost of not doing may prove to be much higher than doing it at this stage, for which there is no alternative in sight. Without such a bold step the gap between the rural and urban India will continue to grow, only to find more migration

from villages to cities resulting in further buildup of slum-dweller populations in cities. Considering the value that Secondary Agriculture can add (two to three-fold) to many sectors of primary agriculture, including crops, animal husbandry, fisheries and poultry area, any investment in this sector is fully justified. It is likely to have a major and sustainable impact on rural (Farmers) income throughout the country.

Significant discussion ensued with regard to the mode of operation that can be effective in yielding the results of any new initiative. It was concluded that any new inputs by the Government must be made, as an investment rather than pouring additional monies in to existing structures that are proving ineffective. It is suggested that the name of the Ministry of Food Processing be changed to the "Ministry of Bio-Processing" to include both food and non-food agro-based industries. Under this umbrella, an autonomous "Special Purpose Vehicle" (Secondary Agriculture Innovation Fund Ltd, SAIF) with the sole purpose of building innovative Bio-processing Ventures be created. SAIF would operate as a business managed by professional venture fund managers and technologists to deliver the desired results. DBT may be able to provide technical support in the appraisal of such proposals.

Stimulating the development of secondary agriculture in India would require **smart capital**. People with talent for investments and experience in deploying innovative technologies and business models and ability to access technologies and markets globally will play a major role in the rapid development of this industry. SAIF needs to be established with a minimum **investment of \$2 Billion** during the 11th Five Year Plan. This investment is expected to be matched by other national and international venture funds in a ratio of 1:1, which would be invested in a further 1:1 equity partnership, making it an **effective investment of \$6-8 Billion**. While 90% of this fund will be invested in various new bioprocessing ventures, a fraction of this investment will be made to establish an Integrated Bioprocessing Technology Institute (IBTI). This institute would have pilot plant facilities and modern processing equipment for providing state-of-the-art training as well as testing (certification), packaging and marketing functions. IBTI will also solicit appropriate national and international technologies and adapt them for the needs of the Industry in collaboration with existing ICAR, DBT and CSIR institutes.

TACSA is proposing that a sum of \$2 billion be invested by the Government to jump-start the secondary agriculture activities as follows:

- This investment, Secondary Agriculture Improvement Fund (SAIF), is to be treated as **venture capital** with expected returns in a defined time;
- An investment of \$200 Million in developing the bioprocessing infrastructure, including building an integrated Bioprocessing Technology institute (IBTI);
- An investment of \$100 Million coupled with additional private Angel Funds of \$100 Million for early stage concept development and proof of concept generation in specific promising bioprocessing technologies;
- An investment of \$700 Million to be coupled with private venture funds for small company development (minimum of 1:1 matching and up to 1:4 matching of SAIF:Private Funds).
- An investment of \$1 Billion for project financing to be coupled with private funds of \$2-3 Billion.

The **cumulative impact of this initiative is likely to total \$6-8 Billion**. The premise behind these investments is that a number of industries are now being established that are leveraging the biomass, agricultural residues as well as processing food, grains, fruits and vegetables, feed etc. to create higher value, longer shelf life and globally marketable products. IBTI with assistance from an international team of about 100 scientists/engineers/agro-marketing experts (INESA) working closely with ICAR and CSIR institutes, can provide the necessary expertise for India to build quality secondary agriculture products to be marketed globally. This institute can also conduct R&D in new frontier areas of technology and help translate scientific research into specific product applications. This institute shall directly work in collaboration with private companies with an independent organizational structure driven by basic business principles. **IBTI should not be an academic institution** granting degrees similar to other national institutes. Rather, it should provide specific training to graduates coming out of other institutes with focus on product development. This will act as a bridge between the academic institutions and industries, a step that is currently missing in Indian agriculture education system.

TACSA believes that all commodity-based ICAR institutes, such as Potato, Sugarcane, Rice

Research etc., should be reorganized focus on value addition to each crop. To strengthen the position of India in the Medicinal plants area, all major medicinal plants research institutes (CIMAP, TBGRI, IHBT and NRC-MAP) should be brought under one super-structure to coordinate their efforts in propagation, processing, QC and new products development, **with a mission to double the export of medicinal plants from India within the next five years.** This can be achieved if genetic and chemical fingerprint certification is provided to growers and processors and appropriate packaging and marketing steps are taken as suggested in this report.

Finally, most of the Indian bio-processing industries as well as training institutes are using outdated and inefficient equipment, while warehouses of fully functional **advanced used equipment are available** in Europe and USA. Again, China is taking advantage of such equipment and procuring it at a fraction (15-20%) of the original cost. To reduce the cost of major new equipments for bioprocessing and packaging plants, it is strongly recommended that all new and **used farm and processing equipments, as well as agro-products testing/research equipments should be fully exempted from import duty and taxes.** The

apparent loss of custom duty on such imports will be more than offset by the low cost of imports and building the new industries which will generate better-paying jobs and taxable revenues within 5 years, thereby **invigorating the entire agriculture sector.**

Only through an integrated approach can one see the fruits from an investment in this area. The recommendations provided in this report, if implemented, would bring about a major change in the agriculture economy of the country and eventually improve rural life, spurred by the secondary agriculture industries, within a short period of time. Growth in this sector is likely to fuel the entire economy, as the **capacity of rural population will increase to absorb goods and services** developed by the industrial sectors in the country.

Progress in this area is vital for the development of the nation at large. India may follow examples from Ireland, China, New Zealand and Brazil, the newly emerging agro-bioresource-based economies. TACSA believes that India can accomplish this mission with cooperation from different parties and coordination at the center **to bring about second green revolution based on secondary agriculture.**

2

RECOMMENDATIONS

Having achieved near self-sufficiency in primary agriculture (food grain, vegetables, fruits and milk production), India must focus during the 11th 5-year plan on Secondary Agriculture, which will allow addition of value to the farm produce and improve the rural economy. The fact remains that agriculture is the only major sector, which has not had new technological inputs after the import of germplasm (wheat, rice and soybean), which led to the “so called” Green Revolution. Meanwhile telecommunication, IT, Biotechnology and other industries (such as automobile) have had opportunities to import new technologies and are slowly changing to the international norms to make them globally competitive. It is time that agriculture processing follow the same path and begin to build international-level companies for which new technologies and equipment are urgently needed and which may be imported, including the used equipment. India should not hesitate to do so to make this sector more competitive. This single step alone will make a visible change within five years.

In this endeavor the role of national institutes is paramount. The focus of ICAR institutes needs to be changed to include crop processing and value addition. There is an urgent need for all institutes to become responsive to the needs of the industry. The recent initiative of CSIR in this direction is encouraging but ICAR/DBT should follow the same path and establish linkages with the industry. Such interactions should be transparent and accountable, with specific goals. The institutions should take the initiative to kick-start new industries. It is surprising to note that no technology developed by any national institutes has given birth to any new industry in India in last 50 years. The 200 or so institutes that now exist should be able to create miracles with proper motivation to scientists and with clearly defined goals. A major structural change

is needed to bring about full utilization of scientific resource available at Indian institutes. The research needs to be translated into business outcome.

To meet the requirements of trained manpower, there is an urgent need to adjust the curricula of all agriculture universities in India to focus on bioprocessing education with practical training, including marketing of agro-products. The role of agriculture extension services must be increased, including broadcasting of information and remote access for improved farm practices, agro-inputs, processing and packaging, as well as market data at the rural level, using web-based technologies.

Only through a close co-operation between the Government, Industry and Institutions can one revitalize agriculture activities in India, including bioprocessing which can add two to three fold value to this sector. In this endeavor, the role of the Government should be of a facilitator, rather than controller with minimum bureaucratic hurdles.

Secondary Agriculture crosses activities in a number of Government Ministries, and hence the Planning Commission may have to take a different approach to this endeavor. The following recommendations are made by TACSA to address various issues affecting Secondary Agriculture Industries development in the country:

A. Organizational Considerations:

1. **At present, secondary agriculture-related activities are spread across several Government Ministries. It is recommended that a Central Office of Secondary Agriculture (COSA) be**

established at the Planning Commission to co-ordinate with various ministries. If this not possible, than a department of Secondary Agriculture Technologies (DSAT) along the lines of DBT may be created.

2. It is suggested that the name of the Ministry of Food Processing be changed to the "Ministry of Bio-Processing" to include both food and non-food agro-based industries and this Ministry assume the primary role of coordinating activity with all States including creation of regional offices of secondary agriculture (ROSA) as well as assuming financial responsibility.
3. A team of international and national experts in each area of secondary agriculture (INESA) should be established to provide technical and marketing inputs to the Ministry of Bio-Processing and IBTI (see below). This team (about 8 persons in each area; for a total of 96) headed by a technically competent leading authority, should interface with COSA to ensure that all programs are implemented in a time-bound manner with international standards and are utilizing the best available technologies for making cost-effective high-quality products.

B. Technical Considerations

4. Similar to other technologies, most of which had to be imported to India, the much-needed bioprocessing technologies must be brought in from international institutions/industries. In an open economy where agriculture is being considered as an industry, the best technologies and equipment should be applied to become competitive in this area.
5. **For seeking and transferring relevant technologies, and providing training in all aspects of agro-businesses value chain -- including marketing and opening new export opportunities for the Indian bioproducts -- a new Integrated Bioprocessing Technology Institute (IBTI) needs to be established. IBTI can tap the resources of INSA and work closely with industries.**

C. Financial Considerations

6. **A minimum of \$2 Billion investment (Secondary Agriculture Innovations Fund, SAIF) by the Government would be necessary to facilitate building Secondary Agriculture Industries across the country during the 11th 5-year plan. This fund should be managed by an autonomous special purpose vehicle (Secondary Agriculture Innovations Fund, Ltd.) with the sole purpose of building innovative Bio-processing Ventures, each operating as a business, under the umbrella of the Ministry of Bio-Processing.**
7. This investment (SAIF) is expected to be matched by other national and international venture funds in 1:1 ratio, which would be invested further in 1:1 equity partnership with new industries, making it an effective \$6-8 Billion investment for various small, medium and large bioprocessing ventures.
8. To demonstrate the full potential of any agro-commodity, examples of high value-addition Industries needs to be set up in each sector. The cost of such setups must be borne 50% by the Central Government, 10% by the State and 40% by the new entrepreneur. Such units need to be World-class and internationally competitive, with a single Government interface provided by SAIF.

D. Institutional Organization

9. **The agriculture curricula at ICAR institutes and agriculture colleges need to be revised to include secondary agriculture, bioprocessing technologies and agriculture marketing courses emphasizing practical demonstrations. TACSA recommends setting up a Task Force for Agriculture Education Reform to implement this change as soon as possible.**
10. All commodity-based ICAR institutes, such as Potato Research, Sugar Cane, Rice Research etc., must focus, in addition to crop productivity, on value addition to each commodity, in direct collaboration with IBTI and the relevant industries. Many of the needed

technologies and equipment have to be imported, which should be given high priority.

11. The entire ICAR system needs to become more project-oriented and Extension activities focused on increased crop productivity, which is essential to provide the raw material for secondary agriculture agro-industries. This would require innovations in soil micronutrients, crop management, drip-irrigation (water management), as well as input of biofertilizers and biocides for sustainable agricultural productivity.

12. **The National Horticulture and Medicinal Plants Mission has a great potential. However, packaging and quality control standards need to be established, including testing and certification for chemical and genotypic fingerprints performed by with adequate regional facilities at the district levels. A Medicinal and Aromatic Plants Certification Office (MAPCO) may be established to accomplish this goal.**

13. Before encouraging the export of any agro-commodity, it needs to be assessed whether such a product can be further processed within the country for higher value addition. A central database for such available technologies and facilities needs to be established and integrated with commodities on the www.secondaryagriculture.org site.

The Ministry of Bioprocessing and Agriculture in consultation with ICAR and CSIR institutes need to develop detailed reports on each agro-commodity addressing the following major points:

- a. **Methodology & Product Definitions**

- Reliability and Reporting Limitations
- Data Interpretation
- Product Definition and Scope of Study

- b. **Executive summary**

- Market Overview
- Trends & Issues
- Product Introduction
- Focus on Select Players
- Global Market Perspective

- c. **Markets**

- North America
- Europe
- Asia-Pacific
- Africa
- India

- d. **Advantage of India in the Export of this Agro-Product**

14. The Agriculture Extension Service needs to be revitalized using web-based technologies at the rural level “linking the farmers with the markets” to inform them about necessary agro- practices, soil inputs, pest management, packaging and processing. The e-Chaupal model can be useful for this activity.
15. The open universities system at Nashik and Delhi may be used for broadcasting Secondary Agriculture-related extension services as well as imparting remote training across the country in the area of primary agriculture improvement and secondary agriculture processing of all major crops.

E. Farm Level Organization:

16. The current farming system in India has become unsustainable and agricultural productivity is not increasing. A consolidated farming, Federated Farmers Farms (3F) system, may be established. This “3F system” will increase primary agriculture productivity and will allow necessary inputs to help spur the secondary agriculture in rural areas. This activity can begin in AEZs that are already focusing on specific agro-commodities and where proposed Mega Food Parks should be located.
17. Alternative crops need to be developed including medicinal plants and biofuel crops. Biofuels production may be focused on lignocellulosic digestion technologies as those can be used for both bagasse hydrolysis as well as other lignocellulosic biomass utilization. TACSA believes that cautions should be exercised for promoting Jatropha for biofuel until it is proven to be safe (toxin-free) and shown to be an economically viable crop. No grain-based alcohol production for biofuel should be encouraged.
18. As the demand for meat is increasing, the control and regulation of animal slaughterhouses should be brought

under one central organization and removed from municipality's control. This would not only create more hygienic conditions and meet the growing demand of this needed commodity; such organized industries would also be able to process all valuable byproducts derived from animal waste to prevent environmental damage. The animal byproducts area is an untapped bioresource for India for which thousands of industries can be developed.

Officers need to be specifically trained to handle such shipments. Any waste due to unnecessary delays in custom clearance is a national wastage and is completely unjustified.

Building a set of bioprocessing industries in a demonstration phase would require establishing one Mega Food Park that can generate sufficient inputs for making valuable byproducts from fruits, vegetables or meat industries. Success in this endeavor can then be duplicated in other locations across the country. If this activity is coupled with IBTI and INESA, then success in this endeavor will be ensured as sufficiently trained manpower becomes available.

E. Infrastructure for Bioprocessing:

19. Besides roads and power, the need for cold storage is vital for uplifting the entire bioprocessing sector, including vegetable, fruits and meat. These cold chains need to be developed by the private sector, with significant subsidies by the Government (40% for construction and 20% on electricity cost). Such cold storage systems must also be more energy efficient as compared to the current systems and should operate year around.
20. **To reduce the cost of major equipment/processing and packaging plants, it is recommended that all farm and processing equipment, agro-products testing/research equipments as well as packaging materials should be fully exempted from duty and taxes. The import of used equipment for agro-industries should be freely allowed with out any license requirements.**
21. Transport of all primary and secondary agriculture products across the country must be open and octroi tax-free, with perishable produce given the topmost priority for exit from such tollbooths. Export of perishable food and non-food items must be given shipping priority. The same should apply to imports of all perishable materials. The Custom

While implementation of all these recommendations may take time and investment, two steps can be taken immediately without significant expense, and both will have a major impact. **These are: allowing import of used processing/testing equipment and consolidating activities of all medicinal plants centers and institutes under one umbrella.** A change in the curricula of all ICAR institutions is urgently needed to meet the growing demand of the food-processing sector, and if this sector is fully developed secondary bioprocessing industries will evolve.

Overall, these 21 recommendations, if followed, could change the face of rural India within 10 years time. Government needs to lead this effort as it is beyond the scope of any single or a group of industries. The scope of the problem is also beyond a single ministry, and that is the reason not much success has come from the Ministry of Food Processing, despite their efforts during the last 10 years, as acknowledged. Only the Planning Commission under the proposed structure may be able to bring about this much-needed change. If India can reach in to space under a mission mode, and become self-sufficient in food production, TACSA believes it is within the capacity of India to accomplish the goal of a Secondary Agriculture mission and change the face of the rural India by bridging the widening gap between the rural and urban economies.

3

INTRODUCTION

The prosperity of any nation depends upon its ability to not only be sufficient in food production but also be able to utilize this renewable resource for making new products and services to create new jobs and grow the agro-based economy. Thus, all developed nations have made a successful transition from their primary agriculture practices to high-value “secondary agriculture” over the last 60-80 years, creating new jobs and building wealth. As a result, their economies have moved from agricultural base to manufacturing and high-tech industries. Agriculture in this process has become a strong biomanufacturing industry creating food, feed, pharma and biofiber for the World markets, and the number of people directly dependent on agriculture has drastically declined in USA (from 60% to less than 2%). The average farmer income in the USA has significantly increased (in 2007, \$81,400/year), twice the per capita income. The total farm GDP is projected to be \$92 Billion in 2008 (USDA Data). Using state-of-the-art technologies US gets the most value out of the agriculture, as does Europe. The average farmer income in India is less than \$850/year.

With India's economy growing by an average rate of 8% a year for several years, euphoria has set in the society that “the country has arrived”. However, this is far from the truth, with the exception of that a small percentage of people. As pointed out by Dr. Swaminathan, while in the eyes of some people India is shining, at the same time millions do not have sufficient food and basic necessities to support their livelihoods. It is a fact that almost 20% of the people in India (almost 225 Million) live below the internationally defined poverty line and the gap between the rich and poor is rapidly widening. Under-nutrition and malnutrition are increasing in the rural population. Nutrition in turn directly affects IQ and the productivity of

people. As population grows (more in rural than in urban areas) the agriculture-based rural economy is coming under greater pressure. The responsibility of food security has been entirely left on the farmer without adequate help from other sectors of the society. Due to inadequate infrastructure and institutional help, the hard-working Indian farmer—one of the world's low-cost producer—is unable to support him/her self, let alone compete globally. In this process, however, he is able to grow enough food to feed the nation.

In an open economy, the food supply cannot be considered to be different than the supply of any other commodities such as clothes, automobiles, or cell phones, only the markets determine where one can buy any products and at what cost. So with the opening of the economy the agriculture sector should also be widely opened for production, processing, transport and marketing of any agro-products, nationally or internationally. Government needs to ensure that the lower end of the population is provided with Food Coupons to be exchanged for basic food at Government-subsidized shops. The shopkeeper should then cash such coupons at the Bank. This will avoid handling of actual merchandise by the Government and the entire process will become more efficient and transparent.

Having achieved near “self sufficiency” in primary agriculture (grains, sugarcane, fruits, cotton and milk), India must now focus her attention to secondary agriculture; i.e., add value to the basic agro-commodities to allow small farmers to get better returns from their efforts, to create new jobs in the rural sector and grow the agro-economy. In Agriculture Summit 2006 organized by FICCI, value addition to agriculture was repeatedly emphasized, and it was stated

that R&D should be re-focused on high value crop products.

The policy on industrialization of agriculture in India needs to be looked at in the same way as the overall industrialization policy in the country. Constraints faced by the agro-industry -- such as supply and delivery chains, high wastage costs, poor capacity utilization, shortage of power and availability of trained workforce, antiquated labor laws, obsolete and inefficient processing equipment, and un-coordinated state and local regulations -- are the same as in the manufacturing industry or even worse. Among these, the unavailability or shortage of power is the key deterrent for locating such industries close to the primary producing region. To develop an efficient secondary agriculture industry in the country, **one-window clearance of all regulations which in turn deals with different departments and ministries, is absolutely essential** for dealing with agro-based industries. Such offices need to be located in small towns within easy reach of the farmer. India has advantages in this sector due to cheap rural labor, a different of agro-climatic zones to produce multiple crops, but this advantage need to be capitalized by removing other constraints and making this industry flourish.

Much of the food processing industry (>70%) is currently unorganized according to the Ministry of Food Processing. This is largely due to the fact that these are small operations, but at the same time the process of creating a registered company is very complex and expensive further discouraging small operators to remain unorganized. Such a system is not conducive for building new companies. The Ministry of Corporate Affairs needs to have a close look at this issue from a rural point of view and create regional offices in towns within the reach of a rural person. The situation is not better in towns and cities depriving the Government from untaxed revenues in this fast growing sector of food processing.

India has the scientific resources available at various CSIR and ICAR institutes, but these resources are compartmentalized, kept away from the industries where this knowledge base needs to be applied. If provided with proper incentives and freedom to collaborate internationally and with local industries, Indian scientists can help build the necessary secondary agriculture industries in the country. A team of interdisciplinary scientists can easily build at least one industry per year, provided that for such accomplishment they are

appropriately rewarded. The seniority-based system needs to be abolished. A merit-based system should be driving all R&D institutions, as it is done in North America. This institutional reform will invigorate the entire R&D sector and allow creation of new industries. ICAR institutes may consider locating private sector R&D units on their premises as CSIR has done in a couple of cases. In addition, they emphasized offshore acquisition of technologies/ intellectual properties developed in other countries.

The ultimate economic growth requires migration of workers based on skills and opportunities in a given sector of the economy. While the urban population is more mobile, in this paradigm, the ability of the farmer to migrate out of the profession in which he/she is engaged is not easy, as they have no other skills. Ultimately, the small farmers will have to move into different labor markets and farms must be consolidated for increased efficiency. Unfortunately, based on the limited industrial growth, there is no variety of labor markets available for the farmers, a step that China has successfully implemented for the transformation of its rural economy (see below).

3.1 Agriculture as the Foundation of Indian Economy

After six decades of independence, India remains predominantly rural with agriculture as its basic resource for subsistence of almost two-third of the population. Until recently, 32% of its GDP depended on agriculture. However, in the last six years the share of agriculture in national GDP has declined to below 20% (in 2008, 18.34%), while the number of people depending on agriculture remains almost the same (about 70%). The trend of decreased share of agriculture GDP in overall GDP in itself is not bothersome. What is bothersome is the fact that India has been unable to achieve a higher rate of growth in agriculture opportunities to create and capture more value both on the production and processing side. This trend, if continued, will further deprive the rural population of participation in the economic growth of the country and further widen the gap between the rural and urban populations.

This situation must be averted with utmost urgency by taking an objective and scientific approach to make this group of people self-supportive and productive, and to integrate them slowly into the growing economy of the country as other developing countries in Asia, such as China have done.

The facts are:

(Source: Outlook, 4th July'2005)

- Almost 70% population i.e. over 750 million people in India are dependent directly or indirectly on agriculture for their livelihood.
- Farmers' income is rising at the rate of only about 1.5% and expenditures are increasing at the rate of more than 4-5% (higher in last year)). Considering the real value of farm commodities in \$ terms, the farmer's income is in fact declining.
- There are about 600,000 villages in India badly in need of basic social infrastructure like all-weather roads, drinking water, regular electricity, primary health care and basic education. Without the improvement in the basic infrastructure, no real industrial growth can occur in rural areas.
- Nearly half of the farmers nationally are in debt trap. In the state of Andhra Pradesh 82% of farmers are under debt and largest number of suicide cases (4000) have occurred in that region.
- Total short-term credit requirement for Indian Agriculture is about US\$ 23.5 Billion while the financial Institutions are able to supply only 12-14% of this requirement.
- According to the Ministry of Food Processing, only about 2.2% of the food is processed, while up to 35% fruits and vegetables are spoiled. Without proper value addition the return on farm produce are minimal.
- Few secondary agriculture industries currently exist in India. Most of the agro industries are focused on food, and more than 70% of this sector remains unorganized.

3.2 Current Status of Agriculture in India

The problems of primary agriculture have been well documented in several reports of the Planning Commission. These include small landholdings, low level of input usage, poor or non-existent extension services (Singh and Vijayraghvan 1995; Prakash, 2001; Swaminathan, 2005), lack of irrigation on two-thirds of the agricultural, land and tardy flow of market information. These and several other constraints (see section 4) need to be addressed to make agriculture more productive and competitive.

On prima-facie, India, from a nation dependent on food imports to feed its population in 1950's and 1960's, is today not only self-sufficient in food production, but also has some reserves. With diverse agro-climatic zones and arable land of 184 million hectares, India has become one of the major food producers in the world with a wide variety of crops, fruits, vegetables, flowers, livestock and seafood. It produces annually 90 million tons of milk (highest in the world); 150 million tons of fruits and vegetables (second largest); 485 million livestock (largest); 204 million tons of food grains (third largest); 6.3 million tons of fish (third largest); 489 million poultry and 45 billion eggs.

Due to continued increasing population pressure, however, the real surplus in the food sector is limited except for seasonal and regional gluts of a few fruits and vegetables due to limited transportation and processing facilities. As the demand for new food and non-food agriculture products increases, the Indian food processing industry is becoming attractive for investors. Actual foreign direct investment (FDI) inflow into this industry in 2005-07 was Rs. 333 crores (approximately US\$ 80 million). This is a very small sum, however, compared to the needs of this industry. As this sector becomes more organized and the demand of processed food increases, growth in this area is expected to be significant during the next decade. This demand needs to be met by building state-of-the-art food processing industries as well as full utilization of all byproducts both for food and non-food usage. This is creating significant opportunities to build new bio-based industries in the country.

For current data on agriculture productivity across the country, and the price of various commodities, see Agriculture Research data Book 2007 (<http://www.iasri.res.in>) and the web site developed by TACSA: www.secondaryagriculture.org.

Indian National Agriculture Research System (NARS) is one of the largest in the world comprising 47 Central Institutes, 5 National Bureaus, 12 Project Directorates, 32 National Research Centers and 91 All India Coordinated Research Projects, as well as 45 Agricultural Universities. Overall, there are almost 190 government and 100 private organizations currently involved in agriculture R&D in India and more are in planning stages. During the 10th Five-year plan 2 ICAR institutes, one national bureau, 3 project directorate and 10 State Universities were created. The size of this enterprise is indeed very large, which has resulted in

achieving significant productivity gains. However, time has come to reorient this establishment for value-addition to primary agriculture to increase farmer's real income and help build the rural economy.

A report on revamping and refocusing agriculture research was submitted by Dr. Swaminathan (2005) to the Planning Commission. In this report, several valuable suggestions were made and it was emphasized that there is a gap in value addition to agriculture; the need for professionalization of agriculture was outlined. The following points are relevant to facilitate the secondary agriculture activities:

- Autonomy of financial management for all institutions of ICAR, including authority for delegating foreign deputation.
- Developing a Creativity Index for scientists and rewarding them accordingly.
- Creation of a National Virtual University for Science in Agriculture.
- A project mode for its research programs, rather than institutional funding, with an integrated system of competitive grants.
- Sharp focus on well-defined output indicators.
- Building a digital gateway for national and international trade in farm commodities. As per TACSA this data should be linked with value addition to farm produce.
- Recruitment system of scientists should be decentralized, with full recruitment transparency.
- Creation of an agro-research and business networking division to bring together academia and industry with biotechnology-centered agribusiness policies.
- Full freedom to institutions for managing research and teaching, and a focus on extension with accountability in performance.

3.2a: The “Apparent Success” in Agriculture

The success in India's agricultural production has been brought about primarily by bringing additional land under cultivation, increasing irrigation facilities, using improved high yielding variety of seeds and plant protection, coupled with judicious use of fertilizers, pesticides and improved cropping practices.

The “green revolution” was, in essence, a direct result of improved variety of seeds with an almost 40-50 fold increase in fertilizer and irrigation. The sustainability of this “apparent success” is in question, however, as crop

productivity is not increasing while the input costs are rising. Furthermore, the need to import wheat and pulses as well as vegetable oil, and most value-added processed foods such as confectionaries and high-protein health foods (which India is currently importing under open license), the contribution of agriculture to GDP is rapidly declining. India imported worth \$2.89 Billion of agriculture products in 2003 (UNIDO). This, coupled with the recent surge in food prices, is placing undue inflationary pressure on the entire economy, particularly affecting the rural population.

The use of fertilizer inputs, which allowed India to increase grain production, has gone from 0.3 million tons in 1960 to 15 million tons at the end of the last century. The productivity per unit land still remains low, however, from wheat, rice and all other crops, indicating a further room for improvement, if proper inputs (particularly micronutrients) are made available and if appropriate farming practices are adopted. These inputs must also include hybrid seeds, micronutrients and biopesticides/biofertilizers. Addition of more chemical fertilizers alone is not likely to improve further crop yields, particularly in already high-yielding areas such as Punjab and UP. Improvement the soil health is essential all over India, an area where farmers need institutional help to sustain further crop productivity. This would allow development of much-needed agro-input industries.

Grain Production: Total grain production crossed 200 million tons in 2005, a big leap from about 50 million tons in 1950. However, the population also increased 3 times during the same period. The production of pulses has declined during this period and India has now become a net importer of pulses. A National Pulse Development Program, covering 13 States, was launched in 1986 but it showed no real impact; pulse production continued to decline. In comparison, Canada where there was no pulses grown 15 years ago, today is supplying pulses to India.

Fisheries: Fish production reached more than 6 million tons in 2006. Various programs that helped boost production include the National Program of Developing Fish Seeds, Fish Farmers' Development Agencies and Brackish Water Fish Farmers' Development Agencies. The Central Institute of Fisheries Nautical and Engineering Training trains the necessary manpower for fisheries. To diversify fishing methods and introduce processed fish products on a semi-commercial scale, an Integrated Fisheries Project was launched. A National

Fisheries Advisory Board has also been established. India, with its large coastal area, has much more potential in fisheries, let alone making fish byproducts such as fish oil, fish gelatin, etc., which are marginal at this stage. The inland fish industry has also grown during the last 2 decades, as has shrimp farming.

With a long coastal line of over 8000 kms, 50,600 sq. km of continental shelf area and 2.2 million sq. km. of agriculture economic zones, India is endowed with rich resources for fishery. Considerable infrastructure facilities for processing of marine products have been developed over the years, but much more effort is needed to tap the full potential of this sector. At present, there are over 370 freezing units with a daily processing capacity of 10,266 tons out of which 150 units are approved for export to EU. About 500 units are engaged in production of frozen fish, with a total storage capacity of 13,4767 tons. In addition, there are 12 surimi units, 5 canning units and 473 units are engaged in pre-processing and dry fish storage. Very few byproducts are made by the fisheries industry except chitin and chitosan and some glucosamine. Almost all of the fish oil is currently imported except for one small plant is recently set up in Kerala. Chitin and chitosan are the two major products made from shrimp waste in India, but many other high value products need to be made such as self-dissolving sutures, chitin bandage for wound healing, omega-3 oil, etc.

Oilseeds: A Technology Mission on Oilseeds was launched in 1986 to increase production of oilseeds in the country and attain self-sufficiency. Before the Mission was launched, oilseed production was only about 11 million tons, which increased in ten years to over 22 million tons. Soybean, rapeseed and mustard largely contributed to the increase in production. The country grows nine oilseeds, with groundnut, rapeseed and mustard accounting for 62% of total production. Lately, soybean and sunflower have shown significant growth. The soybean industry is extracting oil and exporting oil cake at Rs 12-14 /kg, while the country is importing soy protein at 10 times the cost. Soy protein can be made from the same cake that is being exported.

Sugarcane production recently reached to a record of 300 million tons. Transformation of the sugarcane industry to produce high-value biofuels and chemicals directly from sugarcane juice is an enormous opportunity, but the sugarcane industry is running at a loss and many mills are closing or have closed down.

This industry is currently being subsidized by the Government and losing million of dollars in revenue. There is no justification for this situation, except that the industry is inefficient and using outdated technologies that keep it from being internationally competitive.

Food Processing: A Ministry of Food Processing Industries was established in 1988 to ensure better utilization of farmers' output by inducting modern technology into the processing of food products, thus augmenting the income of farmers and generating employment opportunities in rural areas. These efforts have shown limited success so far (see below). Some initiatives have been taken to encourage private sector investment in the food processing industry, but these industries remain largely unorganized and small-scale. Few large players exist and most of them are multinational companies (see Food Processing Section). Attempts to build organized Food Parks during the last two successive Five-Year Plans have not materialized as envisioned, and a new Mega Food Park Program is proposed for the 11th Five year Plan.

India has a unique pattern of production, processing and marketing of milk. It ranks first in the world in terms of milk production. Approximately 70 million rural households (primarily, small and marginal farmers and landless labor in the country are engaged in milk production. Production stands at 91 million tons and growing at a rate of 4 per cent. This is primarily due to initiatives taken by the operation Flood programs in organizing milk producers into cooperatives; building infrastructure for milk procurement, processing and marketing as well as providing financial, technical and management inputs by the Ministry of Agriculture and Ministry of Food Processing Industries to turn the dairy sector into a viable self-sustaining organized sector. While India is able to produce this volume of milk, the productivity per animal remains low, and it is because of the large number of buffalos and cows that such a large volume of milk is produced. This large animal population, however, competes for feed, a valuable agro-resource. Hence there is much room for improvement in milk production by improving the quality of feed, and in this process new industries for the rural sector can be generated. In fact there is no reason why India cannot become an exporter of animal feed with proper nutrition, antioxidants and appropriate packaging. This point was also emphasized in the 11th Five Year plan.

About 35% of milk produced in India is

processed. The organized sector (large-scale dairy plants) processes about 13 million tons annually, while the unorganized sector processes about 22 million tons per annum. In the organized sector, there are 676 dairy plants as Cooperatives, Private and Government sectors registered with the Government of India and the State Governments. Much potential exists in this sector as many milk products can be made including over 50 varieties of cheese, for national and international consumption. Building large industries in this area will require significant technical and financial input with marketing linkage for the export of these value-added products.

More and more people are consuming value-added food products and the import of such food items is increasing. The secondary agriculture industry will not only fill this gap but will also allow significant export opportunities. Growth in these industries can bring immense benefits to the economy by increasing agricultural value, enhancing productivity, creating employment and raising living standards for a large number of people, especially those in rural areas. Thus, there exists innumerable business opportunities in the diverse areas of agro processing for food and non-food products. But, according to the Ministry of Food Processing, the sector still remains largely untapped because of high packing costs, cultural preference of the people for fresh food, seasonal production, demands of raw materials, and lack of adequate infrastructural facilities and quality-control mechanisms. As a result, there is a need to diversify the sector by fully harnessing its potential, providing greater incentives as well as creating a conducive environment for more investments and overall improving the infrastructure. These steps are achievable with cooperation from institutes in delivering crops that can be grown off-season (widening the harvest period), crops suitable for processing, and alternative crops for value addition to farming.

3.2b Real Rural Economic Progress in India

Much has been written and debated about improving agriculture and rural economy in India during the last 10-15 years, including Dr. Swaminathan's recent reports (2004, 2005) on this subject, but little real progress has been made in improving the rural life in India. Whereas the manufacturing and services sectors have been expanding at a rate of almost 10 percent, agriculture has grown by a meager 1.5-2 percent a year. The most disturbing part of India's growth story is that it has widened

regional imbalances, which could cause serious social and political problems in near future as evidenced by the spread of Naxalite movement.

Against the increase in agriculture inputs (fertilizers and irrigation) and the resulting gain in productivity, the value of all agriculture commodities (farm produce) has actually declined in real \$ terms over the last 4 decades, a fact that is often ignored in setting up the minimum purchase prices in India. The cost of living has significantly increased in the mean time, while the real income of the farmers has not (except the large farmers) and the input costs have also increased. The return on investment (ROI), including the personal labor cost, is infect negative for most farmers, hence they are in debt, and some have committed suicide under extreme distress conditions. Farmer in India has no real knowledge of the "cost-risk-return" equation and is simply busy in sustaining his/her livelihood.

The productivity of the Indian agriculture does not compare well internationally. Indian farmers produce less than 3 metric tons of rice per hectare, lower than even the Bangladesh or Myanmar, and much less than the 7.4 tons in the United States. The yield for wheat is 29 percent lower than in China. This low productivity, coupled with lack of value addition to farm produce is not allowing the farmer to get sufficient returns from their produce.

The problem lies at the rural infrastructure, improvement in which would make the real progress. All reports on agriculture addressed the lack of proper infrastructure (roads and electricity) as a major impediment to the progress of the rural economy. And building any agro-industry requires power and transportation, both are limiting. This issue was also considered to be the most important by various people that provided a variety of inputs to TACSA. The topic of basic rural infrastructure improvement is beyond the scope of this committee (TACSA) however, and needs an independent study with a separate action plan.

The improvement in rural infrastructure must be given a top priority, which no private company can do them selves. A rapid built up of the Utrakhand industrial area is an example of that when basic facilities are provided by the Government, new companies can be developed rapidly opening new opportunities for investment. In a very short time span (<5 years), the Utrakhand is witnessing (as visited by some members of TACSA) the fastest growth of world-

class companies in India, creating jobs and boosting the economy of this newly formed state.

Farm structure: The size of Indian farms continues to decline with an average land holding of 1.2 hector per farmer. Such small landholders can be self-sustaining, provided they have access to modern inputs. However, small farmers have high transaction costs in marketing their produce. To overcome this problem, one needs to cluster small farms in economically viable units, be it through contract farming or consolidated farms (see below Federated Farmers Farms (3F), as proposed in this report. Vertically linking these units with processors and retailers (See Food Processing Section) may reduce their risk, promote returns and increase agriculture investments. Indian legal structure however, is not yet conducive for this new paradigm shift in consolidated farming. For this to be realized, trust of the farmers has to be earned and a transparency needs to be established. The recent Chakbandi (land consolidation) that took place in UP has created further debt to the farmers as significant irregularities and bribery apparently occurred in this act. Prof. Verma still holds less than 2 acre land in his name in his village and is well aware of the fact how this piece of land was tossed around a number of times by the officers in charge of this land consolidation process. The entire farm land system needs to be computerized using digital satellite maps from ISARO (see page 58) and taken away from the hands of Tahsildars and Patwaris where the problems seems to be rooted. This can help in creating “Azadi Farms” as proposed in the 3F system (see below) and provide freedom to farmers to disengage from their smallholdings and find alternate occupation, if they so desire.

There is an urgent need for a major overhaul in the legal framework dealing with not only land but also product markets, including Agriculture Produce Marketing Committee (APMC) Act, Essential Commodities Act, restrictions on processing and retailing, and the like. Unless all these bottlenecks are eliminated, major private sector investments in agri-industries are difficult to attract and sustain, and the growth in high-value agriculture will remain a hostage to high risks associated with any such undertaking.

A recent World Bank study finds that the biggest problems for India's agriculture lie outside the sector rather than within it. ***Removing the bottlenecks from farm to market is much more important than raising farm productivity.*** For example, a 20 % reduction in

transportation cost alone will reduce final prices by as much as 10 percentage points, making the final produce much more competitive in the market. This shows the relative importance of different sectors involved in the final cost of any agriculture product. Using practical examples, various business models need to be developed and information needs to be communicated to the farmers via Extension or Direct Broadcasting, to convince the farmers for the needed change in their farm practice.

Irrigation: Water is the most valuable resource for agriculture, without it even the fertilizers do not work. Some progress has been made in irrigation systems and facilities, which has directly affected the crop productivity. However, continued shrinking of the water tables in many parts of India, such as part of the Punjab, is a matter of serious concern not only for farmers but also for the entire society. Often, political slogans like “free power” serve as a mask/substitute for the inadequate investments in the nations irrigation infrastructure. As has been pointed out in the media (<http://indianeconomy.org/2006/07/01/>) “the notion that farmers are not willing to pay for guaranteed supply of electricity and water is not correct as one needs only to look at some of the things farmers are borrowing money for, it is water for irrigation. While they borrow thousands for digging a bore-well, they should be more than willing to pay one or two hundred rupees per month for their centralized water supply.” The idea of “free electricity for farmers” has created over watering in certain areas and lowering the water table in other areas as is happening in Punjab. A public-private partnerships can close the gap between the supply and demand for irrigation for which government has to take the politically difficult step of telling the farmers that the “free water is not really free, but it may be hurting them rather than helping”. The social cost of such “Freebees” is much higher than initially envisaged.

Agriculture Subsidies: To ease these pressures, the Government is providing various forms of subsidies to the farmers. At present almost 49 Central and State level agencies provide incentives/subsidies under various schemes (FICCI 2006). These subsidies, both open and disguised, have grown to a point, however, where they are at the verge of creating the basis for a new fiscal crisis, as they become unsustainable in the “open economy” (Dorin and Jullian, 2004). It is not surprising to see that much of this help is not filtering down to the farmers as it gets mostly absorbed in the “system”. If made transparent, these subsidies

can in fact change the primary crop productivity as well as allow significant value addition to agriculture commodities. The farmer is either unaware of or is incapable to tap in to these schemes and only a fraction of the farmers currently take advantage of such a system. The recent waving of farmers loan may put further pressure on this situation. The crises are looming in the cooperative sector as well (see below) as regulatory framework is not strictly followed and some of these organizations are losing focus. The food subsidy is in fact needed to support the below poverty line families, but it should be in the form of "Food Stamps" redeemed for grain or sugar and Government should not be handling agriculture commodities itself; that function needs to be carried out by the private sector to avoid waste and increase efficiency.

Significant outlay and expenditures are being made for the agriculture sector but given the number of programs (schemes) handled by a myriad of agencies, the impact of these funds is very limited. As suggested by FICCI (2006) these agencies need to be brought under one umbrella to reduce administrative costs and reduce duplications. This step, coupled by e-governance would increase impact of this effort significantly and help bring about the desired results without extra outlay of moneys. A structural reorganization of the entire ICAR system including change in agriculture Extension System is urgently needed to have an impact of various policies and incentives on agriculture productivity.

3.3 Agriculture Expenditures and the Economy of India

Agriculture plays an important role in Indian economy and the expenditure on agriculture have been increasing in successive Five Year Plans. The data in Table 1 shows the share of agriculture GDP in the total economy of India taking in to consideration all major industries. ***This data suggests that the share of agriculture GDP in the national economy has further declined and stands at 18.34%. This is a matter of serious concern as the percentage of people depending on agriculture is not decreasing with the same rate, indicating further widening of the gap between the urban and rural economies.*** This is consistent with the fact that the agriculture economy is only growing at a rate of 1.5 to 2% while the rest of the economy is growing with a rate of over 8%.

Table 1: Gross Domestic Product of India by industry

Industry	(Rs. In Crore) Of current price
	2006-07*
1. Agriculture, Forestry & fisheries	695,424
1.1 Agriculture	634,519
1.2 Forestry & Logging	26,855
1.3 Fisheries	34,050
2. Mining & Quarrying	101,816
3. Manufacturing	617,954
3.1 Registered	428,909
3.4 Unregistered	189,045
4. Electric gas & Water Supply	70,563
5. Construction	319,457
6. Trade hotels & Restaurants	630,364
6.1 Trade	570,888
6.2 hotels & Restaurants	59,476
7. Transport, Storage & Communication	319,104
7.1 Railways	39,308
7.2 Transport by other means	200,722
7.3 Storage	2,535
7.4 Communications	76,539
8. Financing, insurance, real estate & business services	526,755
8.1 Banking & Insurance	218,883
8.2 real estate, ownership of dwellings & business services	289,703
9. Community, social & Personal services	508,586
9.1 Public administration & defense	218,883
9.2 Other Services	289,703
10. Total gross domestic product at factor cost	3,790,063

Note: a) In 11th Five Year Plan there is an additional allocation of Rs. 25000 crore for the Rashtrya Krishi Vikas Yojana (RKVY) by way of an ACA.

b) Additional Rs 1,000 crore in 2007-08 RE and Rs 3,165.67 crore in 2008-09 BE were provided for ACA scheme of RKVY*.

c) Additional amount of Rs. 30 crore in 2005-06, Rs. 40 crore in 2007-08 and Rs 40 crore in 2008-09 were provided for the State Sector scheme of control of Shifting cultivation in NE Region.

Data from the Planning Commission.*Guidelines

for National Agriculture Development Program (NADP)/Rashtriya Krishi Vikas Yojna (RKVY), Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India (August, 2007).

Table 2 shows the expenditures of the three major Agriculture Departments. In addition to these expenditures, there are other programs administered by the Ministry of Rural Affairs that impact the rural economy. A significant increase has occurred in the outlay for agriculture in the 11th Five-year plan. These funds (Rs 61,979 crores, almost \$ 15 Billion), if appropriately used, should be able to deliver world-class science and technology-driven agriculture

output. However, it may be pointed out that adding more resources to the same inefficient structure will not increase agriculture productivity. If the recommendations made in the Swaminathan's report (2005) are followed to revamp the system and an integrated, transparent e-governance system is adopted, a "second agriculture revolution" can emerge based on the secondary agriculture bioprocessing industries as proposed here, revitalizing the entire rural economy of the country. Simple increase in outlay may not solve the problem because the problem lies at a different level, which must be addressed in order to make concrete progress in this area.

Table 2: Outlay of Expenditures in three Agriculture Departments during 2005-to 2008.

Deapartments		DAC	DAHDF (Rs. In crore)	DARE	TOTAL
S. No	Year				
1	2005-06 (BE)	4,179.32	669.08	1,150.00	5,998.40
2	2005-06 (Actual Exp.)	3,817.46	589.37	1,046.75	453.80
3	2006-07 (BE)	4,800.00	777.00	1,350.00	6,927.00
4	2006-07 (Actual Exp.)	4,637.70	677.20	1,283.21	6,598.11
5	Eleventh Plan	41,337.00	8,054.0	12,588	61,979.00
6	2007-08 (BE)	5,520.00	910.00	1,620.00	8,050.00
7	2007-08 (RE)	5,887.94	810.00	1,434.00	8,131.94
8	2008-09	6,900.00	1,000.00	1,760.00	9,660.00

Data from the Planning Commission of India.

DAC: Department of Agriculture and Cooperation

DAHDF: Department of Animal Husbandry Dairying and Fisheries

DARE: Department of Agricultural Research and Education

3.4 Value Addition to Primary Agriculture

Raw material is the end product of primary agriculture. Further processing of the primary commodities adds value. Farmers in India have been deprived of taking part in this value-chain as simple flour mills, oil and dall mills, packaging and labeling involves so much of bureaucratic hurdles to set up any operation, that this activity is left to traders and industrialists. They also engage in activities that allow minimum value addition as they do not have access to state-of-the-art technologies and help needed to develop any high-risk ventures in this area.

Value addition to farm produce can be achieved at three levels:

Level 1: Post-Harvest Primary Processing:

This involves cleaning, sizing and packaging. This is primarily applicable to fruits and

vegetables. As suggested by Swaminathan (2007), value sharing with the producer is very

important. Management of supply chain, establishment of cold chains, off-season production, is all-important factors. At this level there is a very small value addition but also very little business risk.

Level 2: Post-Harvest Secondary Processing:

This involves basic processing, packaging and branding. This is applicable to grains and grain products. For example brown and polished rice, wheat (*atta*, *suji*), maize (corn flour, animal feed ingredients), etc. India's agro-industry is primarily at this stage. The industry needs consistent and reliable supply chain and competitive prices of the basic commodities. It is a high volume, low margin business. India has several thousand flour mills but none of them is large enough to gain brand recognition through out the country. The Ministry of Food Processing needs to assist in setting up standards for these industries and ensuring the quality of the produce.

Level 3: High-End Processing: This involves complex processing technologies, equipment and finance. Thousands of products can be made from grains of corn, wheat, soybean and rice as well as other cereals. Corn, among the cereals and soybeans among legumes have been extensively worked on in the US, wheat in Europe and the US, and rice in Japan to produce thousands of food and non-food products from these grains.

High-end processing is a global industry. In India, it is at an embryonic stage of development. It is capital intensive, highly technology dependent and competitive. The market capitalization of the key global players runs into several Billion (B) dollars each (ConAgra 12B, ADM 29B, General Mills/Pillsbury 19B, Nestle/Purina 177B, Corn Products International 3B). The entry barrier to this industry for competing internationally is extremely high. But the size of the Indian market is so large that any company entering this area can succeed even on the national markets.

Agro-industry offering niche products that are high up in the value chain and have high margins are rare in India. High margin products have to be unique to occupy niche markets. This requires innovative technology creation at the institute or industry level and marketing of the product internationally. The latter may need building collaborative ventures.

Thus, the secondary agriculture industry has two options. It can stay small scale at the village/town level to make the products that local people need, or leapfrog into unique products in the national and global markets. Both models are not mutually exclusive as there is a need for two types of industries in the mixed economy of India.

All Industries normally operates on four basic business principles: value creation, value protection through trade secrets or patents (IPR), value sharing and value recovery. It is important to keep in mind that even in the developed countries where value addition is the norm, the spread between what the producers gets and what the consumer pays is going down % wise. The processor benefits the most, the retailers, wholesalers and consumers benefit as well as the middleman but very little does the producer. **We need to make sure that the same does not happen in India and a mechanism is created by which value is shared with the producer.** Having producer cooperatives is one way to share value with

them. The other option is to let the processor directly contract with the producer or through a contractor for procuring raw materials. This is the model that has been developed successfully in the flourishing seed industry in India. Or develop small scale processing industry (mini mills for wheat, rice, corn and *dal*) at the village level that can benefit the villagers by providing them with the products they need as well as supply these products to the urban area. This area needs to be completely deregulated for various licenses etc., except the safety of the workers and the quality of the food product the company produces.

To develop secondary agriculture, one needs the same ingredients that led to the success in developing primary agriculture in India. We need to revitalize agricultural education (CAR 1981, 1995) with emphasis on agricultural diversification, and technologies to produce value-added agricultural products. The key agriculture universities in the country need to have a dynamic bioprocessing center that works on innovative technologies on food storage, processing including byproducts and works closely with the industry. An efficient and cost-effective transparent mechanism must be developed to transfer any innovative technologies to the industry that are created or accessed by them in developing value-added products. In essence, all CSIR (life sciences related institutes) and ICAR institutes must work hand-in-hand with the industries. Since these institutes are supported by the public funds, they must be freely accessible to all Indian Industries who may need such technologies.

3.5 Primary vs Secondary Agriculture

The first step in building secondary agriculture is improving the food processing industries followed by the use of agriculture in making fiber, chemicals and industrial non-food products. At present the total value added by the food processing industry in India is only about 8 per cent of the total food production. As stated above only about two per cent of horticulture products are processed while more than 35 % of fruits and vegetables are wasted due to the lack of storage and processing facilities, and very few secondary products are derived either for food or non-food use.

A classic example of secondary agriculture driving value addition to basic bioresource to produce a series of higher value products is shown in Figure 1. India having a coastal area of over 8000 Km cannot cultivate enough seaweed to make agar, and currently seaweed is

being imported from Spain to make agar, let aside further value addition, which can be thousands of fold higher. Taiwan is successfully accomplishing this goal and supplying these products to the international markets. PepsiCo (USA) has recently set up an Agar producing

plant in India primarily for their own use of this product. Note that agar can replace gelatin in vegetarian cooking and is nutritious for health, but its use in Indian food is very limited and has not been promoted.



Figure 1: Example of value addition to marine bio-resource as a multiple in thousands.

Wine industry is another example of secondary agriculture, where India is recently venturing in to. This is a large global industry of over \$95 billion/year where only few countries have established their product quality. Wine making is an art that cannot be mastered in a short time, hence quality wines are difficult to make. India needs to forge technical and marketing collaborations with wine making industries in Australia, Chile and Argentina who have been able to master the art of wine making in a relatively short time and have established successful marketing links with USA and Europe. The current wine produced in India is not of high quality and is very expensive, partly due to heavy excise duty, cost of glass bottle and cork (which is currently imported). India has a great potential in this area, but this industry needs to be nurtured to make it internationally competitive, otherwise India will be flooded with cheap wine imports from other countries. This industry produces significant valuable byproducts as phytechemicals and natural dyes (see below), none of which are currently made in India and therefore it offers great opportunity for investment by the private sector to build such industries in close proximity of wineries.

The use of agro-bio-resource for making non-food products for industrial use is extremely limited in the country while thousands of such products are made in US and Europe (see, for example corn and soy byproducts in Food Processing Section) where these industries are well developed and many Asian countries are currently developing their agro-based industries. Some members of TACSA visited a modern plywood facility in Pant Nagar, Uttaranchal that uses whole poplar tree as a raw material to make a value-added finished plywood product;

the result is that farmers in that area now receive twice the value for their raw material. This is one of the many clear examples of successful secondary agriculture industries. Similarly, India Glycols Ltd. makes value-added chemicals from ethanol made from sugarcane juice, but it has to compete for raw material (sugarcane) with the sugar industry, which is protected.

The efficiency of production reduces cost and increase competitiveness. For example, with 5% of the World enzymes industry Denmark produces 47% of the World industrial enzymes. In contrast, although India produces largest number of animal hides its share in the World leather market is only 1.5 % as compared to Italy that has only 2% of the World cattle population but produces 51% of the World finished leather and leather goods. India has a lot of potential in these industries if the right technologies and marketing is used. The animal byproducts industry can be very large in India since millions of animals are slaughtered every year and die with natural death. Very few byproducts are currently being made in India.

3.6 Present Agro-Based Industries in India

India primarily produces food-related products from agriculture and most of the agro-industries are centered around the basic food commodities. Very few high-value products, such as chemicals from ethanol generated by any industry, and most such products are imported such as pure proteins, starch, enzymes, adhesives, biochemicals etc. The primary agro-bio-industries in India are:

3.6a Food and Feed-Related Agriculture Industries

i. Bakery & Confectionery Products

Bakery, Biscuits, Chocolate Chip, Chocolates, Cocoa, Confectionaries, Confectionery, Cookies, Deoiled Cake, Drinking Chocolates, Bread, Cakes, Malted Foods, Sweets, Pastry, Toffees

ii. Edible Oil & Allied Products

Coconut Oil, Cooking Fats, Cooking Oil, Cumin Seed Oil, Edible Oil, Castor Oil, Celery Seed Oil, Ajowan Oil, Margarine Oil, Refined Oil, Refined Vegetable Oil, Rice Bran Oil, Sesame Oil, Sunflower Oil, Mustard Oil, Groundnut Oil, Herb Oil, Vanaspathi Ghee, Vegetable Oil, Oil Products, Table Margarine

iii. Dry Fruits & Nuts

Dry fruits, Cashew Kernels, Cashew Nut, Cashews, Almonds, Roasted Dry Fruits, Peanuts, Groundnut, Walnut Kernels, Walnuts, Indian Peanuts, HPS Groundnuts

iv. Dried, Preserved & Dehydrated Fruits and Fresh Vegetables

Bananas Dried, Bananas Fresh, Beans, Cherry, Cucumbers, Dried Fruits, Dried Truffles, Dried Vegetables, Carrots, Lemon, Mandarins, Mangosteens, Meslin, Shallots, Spinach, Mixed Vegetables, Mushroom, Mushroom Spawn, Oranges Fresh, Papaya, Pineapple, Potatoes, Preserved Fruits, Preserved Vegetables, Radiata Dried, Fresh Apples, Fresh Asparagus, Fresh Fruits, Fresh Grapes, Fresh Oranges, Fresh Vegetables, Gherkins, Grapes, Fresh Turnips

v. Milk & Dairy Products

Cheese Spread, Condensed Milk, Curd, Dairy Products, Dairy Whitener, Dry Yeast, Butter, Cheese, Ice Cream, Ice Cream Corns, Milk, Milk Cans, Milk Powder, Milk Products, Paneer, Extract Powder, Flavoured Milk, Yeast

vi. Miscellaneous Other Agro Food Products

Bajra, Barley, Dried Marine Products, Cane, Jaggery, Agro Commodities, Agro Product, Jaggery Powder, Sorbitol, Soya Meals, Starch, Sugar, Namkeens, Natural Honey, Onions, Papad, Flour, Foodstuffs, Glucose, Gluten, Groundnuts, Honey

vii. Pickles, Chutneys, Ketchups & Sauces

Chilly sauce, Chutney, Chutnies, Ketchups, Lemon Pickles, Mango Pickles, Sauces, Soya Sauce, Synthetic Vinegar, Mustard Sauce, Pepper Sauce, Pickles, Garlic Sauce, Tomato Ketchups, Tomato Sauce

viii. Tea & Coffee

Black Tea, Coffee, Coffee Beans, Darjeeling Teas, Assam Teas, Indian Tea, Instant Coffee, Leaf Coffee, Leaf Tea, Packaged Tea, Green Tea, Tea, Tea Bags, CTC Teas

ix. Processed Food & Snacks

Canned Fish, Canned Food, Malt Extract, Snacks, Soup, Soup Concentrate, Soup Powder, Porridge, Potato Wafers, Processed Chicken, Processed Foods, Processed Seafoods, Processed Snacks, Fish & Sea Food, Frozen Fish, Frozen Meat, Frozen Shrimps

x. Rice, Wheat, Pulses & Other Food Grains

Cereals, Maida, Maize, Rice, Rice Bran Extractions, Sorghum, Soymeal, Suji, Parmal, Pulses, Wheat Flour

xi. Spices & Derivatives

Black Pepper, Chilli Powder, Chillies, Cinnamon, Cloves, Coriander Powder, Cumin, Curry Powders, Dry Ginger, Dry Red Chilly, Cardimum, Cardamom, Chat Masala, Chatni, Anise, Indian Spices, Salt, Spices, Spices From India, Onion Powder, Pepper Fenugreek, Seeds, Garam Masala, Ginger, Hot Spices, Turmeric, Turmeric Powder

xii. Meat & Poultry

Bacon, Egg, Livestock, Lyoners, Meat, Mortadella, Peppero, Poultry Feed, Poultry Food, Frozen Meats, Ham

xiii. Cattle Feed Supplements

Cattle Feed, Animal Feed, Animal Feeding Stuffs, Fodder

xiv. Marine Food Supplies

Dried Beche-de-mer, Dry Fish, Aqua Foods, Marine Food, Marine Products, Sea Cucumber, Sea Food, Shrimps, Prawns, Frozen Marine Products

xv. Liquors, Mineral Water & Beverages

Beverages, Beverages, Brandy, Aerated Water, Alcoholic Beverage, Liquors, Rum, Sandpiper, Schweppes, Soft Drinks, Spring Water, Mineral Water, Fat Liquors, Gin, Vodka, Whisky, Wine, Indian Liquor, Indian Wine

3.6b Non-Food Agri products Industries

i. Dyes & Color Additives

AZO Dyes, Colors, Color Additives, Color Additives, Cottex Dyeing, Dye intermediates, Dye Makers, Dyes, Dyestuffs, Cationic Dyestuffs, Acid Dyes, Reactive Dyes, Pigments, Fabric Dyeing, Textile Dyeing, Vet Dye

ii. Fertilizers

Bio Fertilizers, Biocides, Agriculture Fertilizers, Natural Fertilizers, Non-hazardous Non-toxic Fertilizers, Organic Fertilizers, Organic Manure, Fertilizers, Fertilizer Mixtures.

iii. Flowers, Floriculture & Dried Flowers

Dried Floral Items, Dried Flowers, Dry Flower, Bouquets, Cane Flowers, Lotus Pods, shola Flowers, Palm Leaf, Floriculture, Flowers, Foliage, Handmade Flowers, Live Plants, Natural Dried Plants, Grafted Plants

iv. Pet-Use Products, Pet Furniture & Allied Products

Dog Biscuits, Raw Hide Bones, Pet Products

v. Seeds, Buds, Plantation & Related Products

Basil Seed, Cumin seeds, Dill Seed, Buds, Celery Seed, Hybrid Seeds, Seeds, Sesame Seeds, *Sesbania* Seed, Sunflower Seeds, Mustard Seeds, Oil Seeds, Plant Products, Plantation, Plants, *Psyllium* Seed, Fennel Seed, Fenugreek Seeds, Herb Seeds, Tamarind Seed, Vegetable Seeds

vi. Tobacco & Tobacco Products

Beedi, Betelnut Leaves, Betelnut Supari, Bidi, Bidi Leaves, Chewing Tobacco, Cigarettes,

Arecanut, Jarda, Scented Tobacco, Smoking Items, Smoking Tobacco, Snuff, Supari, Opium, Pan, Chatni, Pan Masala, Pan Parag, Tobacco, Tobacco Products, Tulsi Mix, Gutkazarda, Tulsi Zarda, Tobacco, Zafrani Zarda

vii. Industrial Products

Chemicals, biofuels, adhesives

(Data from: <http://dir.indiamart.com>)

viii. Other Related Industries

A variety of other industries utilize agro-bioresource which are not perceived as agro-based industries. These include, cosmetics, clothing, furniture, construction (wood, bamboo), and restaurants, providing much wider impact of agro products.

As evident from the above list of industries in the country most of agriculture produce is geared towards food items and very little non-food products are being manufactured at present providing great opportunity to diversify agriculture, create jobs and to grow the agro economy. This, however, will require significant technological and financial inputs, both of which must be made to grow this sector. Farmer alone cannot achieve this goal.

4

SECONDARY AGRICULTURE

The definition of secondary agriculture is very broad as it includes all food and non-food bioresource-based products for human and industrial use. Thus, this area crosses many regulatory boundaries and falls, in India, under the control of different Government Ministries. Technically also, it involves production, processing, packaging and marketing expertise, in addition to developing new technologies and products. It also affects all sectors of society with specific impact on the rural population as they solely depend on agro-bio-resource to sustain their livelihoods.

4.1 Constraints

The constraints faced by the agro-industry, such as, supply and delivery chains, high wastage costs, poor capacity utilization, shortage of power and trained workforce, antiquated labor laws, obsolete and inefficient processing equipment, and hodgepodge of state and local regulations, are the same that are in the manufacturing industry or even worst. Among the shortage of power is the key deterrent for locating such industries close to the primary producing region. To develop an efficient secondary agriculture industry in the country, building one window clearance of all regulations, which in turn deals with different departments and ministries is essential. India has an advantage in this sector due to cheap rural labor, a number of agro-climatic zones to produce multiple crops, but this advantage needs to be capitalized by removing other constraints and making this industry internationally competitive. Let farmer learn how to build an agriculture industry before over regulating it. Farmer cannot deal with the layers of bureaucracy, licenses and be able to produce and market the produce at the same time.

Secondary agriculture industry will develop if there is confidence in the technology, market demand, access to raw material, available entrepreneurial resources, and of course capital for diversification. That doesn't mean there are no roadblocks. India's infrastructure is improving but very slowly. Power supplies are iffy, so companies typically need their own generators. For large as well as small industries this adds significant cost to the final products, let aside the pollution and waste such practices create. Ports, though partly privatized, are still overcrowded and not fully modernized to handle increase in trade. This inefficiency further adds to the cost and makes some products (particularly perishable produce) highly vulnerable for international trade. Export of frozen vegetables and meat are subject to these limitations

Technical: Inadequate technologies have failed India to provide industrial revolution it was seeking, and the limited urban industrial activities that have evolved, are not able to adequately absorb migrant rural population, which is ending in creating larger slums in urban areas. At the same time, large food processing industries have not been able to locate in the rural areas due to poor infrastructure. This has left rural area mostly undeveloped and the percentage of unemployed youth is the highest in villages. This is creating serious problems in many rural areas, including building of "Naxelite movement" in some southeastern States.

Technical inputs are vital for building and survival of such industries. Much of the new technologies and machineries have to be obtained from abroad as very few Indian technologies and machineries have been developed to make this sector internationally competitive. For the small and medium size industries, which cannot afford expensive and

imported technologies and the technical consultants on regular basis, the involvement of Indian institutes/scientist in such projects would be vital for their success. All life sciences and agriculture graduates and professionals should be required to take part in such endeavors wherever possible. The Indian scientists have been kept away from industrial interactions for the last 60 years, and the results are now affecting the growth of the new generation industries. In fact there is a shortage of skilled manpower in all areas because the core competency is lacking, particularly in fields where the students never had hands on experience with relevant equipment or technologies. Simple theoretical knowledge is not sufficient to deal with the complexity of technologies and instrumentation in today's industries and practical experience is lacking in most of the graduates of agriculture institutes, creating significant problem for this industry. Visits by some TACSA members to several institutes such as CFTRI, CMAP, and NCL etc did revealed some progress but these technologies are primarily for rural level small-scale industries. A list of some of these technologies is available at <http://mofpi.nic.in/technologies/index.htm> and www.secondaryagriculture.org. CFTRI had published *A Compendium of Selected Technologies on Food Processing in Rural Sectors*, however, this document is out-dated and other more viable technologies have since been developed. The fact that no successful company has ever been created by any Government institutes in India is a matter of serious concern. In contrast, just three universities in England (in Cambridge triangle) built over 1000 companies in last 10 years. Most scientists in USA are involved in developing patentable technologies and often work with industries as consultants and many have equities in companies. Most of the biotechnology companies in USA (over 2000), such as Genentech, and Amgen, were started by scientists from universities. There are only 2 examples of such companies in India.

Policies: The policy on industrialization of agriculture in India needs to be looked at in the same way as the overall industrialization policy in the country. Agro-industries friendly policies with minimum bureaucratic hurdles and with a single-window clearance are essential for the birth of such industries. **TACSA suggests that all such industries up to a capitalization of Rs. 10 crore should be completely free of any taxes and regulations (except the pollution control and pay roll taxes).** Let these industries first take birth, grow and than tax

them, rather than collecting upfront taxes even on invested capital. India is the only country where incorporation of a new company is made so difficult that people hesitate to register a company and the sector remains mostly unorganized. A new ministry was created to facilitate the formation of new industries, but it has made registration process even more difficult. To face such burgeoning bureaucracy is a herculean task for any ordinary entrepreneurial person (particularly in the rural area) and to risk his/her limited capital in the face of limited technologies and mountain of hurdles. The process needs to be simple and transparent with full accountability and time line for execution.

In USA one can open a company in 30 minutes over the phone with any name, if available, and get a Tax ID number (while in India even the use of specific words, such as India, World, International or Corporation, is restricted in the name of a company). After incorporation no one bothers a new company for 10 years if such operations do not pollute and simply follow safety regulations. This simplicity has allowed creation of millions of companies, supporting the bulk of the Tax system and all applicable taxes are directly collected from the payroll. Simplification of the company registration systems will help bring more unorganized activities in to the organized sector and increase the tax base by collecting the payroll tax. Specific efforts are needed in this area as majority of the food processing companies are in the unorganized sector and these processors need to register and follow certain safety regulations while supporting the tax system.

4.1a Rural Infrastructure and Building Agro-industries

While the whole world is looking at the potential of India to grow fast, it is well acknowledged that India has the weakest infrastructure to support its industrial growth and hence expectations are cautioned by the global financial sector. The continued GDP growth largely rest on much needed improvements in infrastructure. This is particularly so in the rural area where agro-based industries need to be located. It is no surprise that wherever a road is laid down in the rural area development starts around it immediately, only to find after few years that it has become an "internal street of the town" which has grown around it. Although some progress has been made in rural electrification and road connectivity, a significant number of villages do not yet have any electric supplies and roads to connect them to an urban area. Those that have some connectivity, the supply of

electricity are highly intermittent and unreliable (maximum 2 to 6 hrs per day). The first requirement for any industry to be set up in a rural area is the availability of reliable electricity supply and road to connect it to an urban area. One cannot run such industries on diesel power generators, which may be adequate for the IT industry, but not for the agro-industries. This daunting situation is depriving millions of people from betterment of their livelihoods as they cannot process or transport any produce they are able to grow with limited inputs. While this should be the top most priority of the Ministry of Rural Development, the basic fact is that there is significant shortage in power generation and supply all through out the country (with the exception of few urban centers).

The shortage of power stems from the fact that besides limited generation capacity, almost 50% of the power generated by India is either stolen or grounded (particularly in rainy season). Almost all industries suffer from inadequate power supply, and those that try to generate their own power, it costs them 2-3 times more for the same unit of power, making that industry less-competitive. This issue was addressed in a Planning Commission Report on Integrated Energy Policy (Parikh, 2006) emphasizing various measures to be taken. The fact that China has been able to grow with such a fast rate is coupled with the ability of that country to generate adequate power to meet the demands of its growing industries and locate such industries in the rural area to create jobs and prevent urban migration. **There is no substitute for power, the only choice is how to produce it, be it hydro, coal, solar, nuclear or biofuel-generated. This is the single most-limiting factor in the growth of rural industries in India.**

Recent progress in building interstate highway structures is a step in the right direction but such highways must be Non-stop (fenced on both sides, at least near the populated areas) and be free of octroi duty on agriculture produce so that farmer/processor is able to transport any goods effectively any where in the country. This is essential to empower not only the farmers but also other processors who need to transport the semi-finished or fully processed products at significant distances.

The transport situation directly affect the value of agriculture goods, particularly if they have to be transported across the country, and results in local seasonal surplus of produce which neither can be processed nor transported and left to waste, costing farmer significantly. A

cauliflower sold at Rs 2.00 each on the road side in Orissa (see Fig, 2), if packaged and transported the same produce can fetch 10 times more price in Kolkatta, only 200Km away.



Figure2: A roadside farmer's market in Orissa. Dr. V. Dwivedi, Joint Secretary PC, asking for the price of cauliflower, which was Rs. 2.00 each. They discard any vegetable that is not sold by 4PM, resulting in heavy losses due to lack of packaging and transport.

During the visit to Orissa some TACSA members also had an opportunity to see first hand the condition of tribal people in Patna, near Baleswar. This was a shocking experience to see that how people survive with practically no means to support their livelihoods, such as water, roads, farming tools, let aside road and electricity. This area however, is rich in medicinal plants and these tribes have knowledge of such plants, which can be brought under cultivation giving them a means of supporting themselves. **TACSA suggests that a separate report be prepared to address this issue, which is affecting millions of people living in 100's of tribes across the country.**

The lack of proper infrastructure discourages companies to locate any production units in rural areas because there are neither trained people available there nor one can take people from out side and expect them to stay in such places where there are no reliable schools, police, hospitals, roads and supply of electricity. These five factors are fundamental to develop any civic society and industries, a task, which no private company can do alone. It is therefore vital that each district focuses on developing industrial zones, including placing Food parks in such zones where these 5 basic facilities are available at par with any urban area. Only then can one expect that secondary industries will grow and create new jobs to prevent the migration of rural people to cities in search for jobs. The major constraint in developing processing industries near the plantation area, is the availability of roads and power. The Government needs to assure building of roads wherever necessary and providing power lines to support such industries in rural clusters where agriculture industrial zones (AEZs) and Food Parks can be located and Secondary Agriculture Industries can be build close to these clusters.

The proposal announced in Feb. 2008 by the Union Finance Minister Mr. P Chidambaram to invest Rs. 14,000 crore for the Rural Infrastructure Development Fund (RIDF) would provide a much-needed relief, if these funds can be effectively utilized to link AEZs with the urban centers. The Finance Minister also proposed to operate a separate window under the RIDF-XIV for rural roads with a corpus of Rs. 4,000 crore. This along with the completion of the Golden Quadrilateral (96.48 per cent) and the North South, East West Corridor project (23.36 per cent) would provide much needed relief. The need for rural infrastructure development is significantly higher however, to provide integration of the mass of rural people in to the growing economy as China is doing (see below). A report on Agricultural Infrastructure was prepared by Dr. Prakash in 2001 which addressed warehousing, rural godowns, marketing, postharvest management, processing and cold storage, trade and export of agriculture commodities. This report provided the state of current situation across the country and emphasized the need to improve this basic infrastructure during the 10th Five Year Plan. In this report an integrated system of food storage, including irradiation and cold storage, to minimize postharvest losses was emphasized. Much remains to be accomplished along those lines that was outlined in that report and re-emphasized in the FICCI Agriculture Summit, 2006.

Rural Infrastructure & Services Commons (RISC): A concept paper co-authored by Vinod Khosla and Atanu Dey (USA) few years ago on Rural Infrastructure and Service Commons for India (RISC) is interesting in this context. In brief, the **RISC idea is to bring to the rural population the full set of services that are normally available only in urban locations.** It proposes to function within the constraints of limited resources by focusing attention to and concentrating investments at specific locations to obtain economies of scale, scope, and agglomeration. RISC proposes coordination of activities of a host of entities: commercial, governmental, NGO's. It may help synchronizes investment decisions so as to reduce risk. It essentially acts as a catalyst that starts off a virtuous cycle of introducing modern technology to improve productivity that increases incomes and thus the ability of users to pay for the services. As the need for such services grows in rural areas, they must be made available within reach. **A clustered self-sustainable approach is the only way that this goal can be realized as demonstrated by e-chaupal concept of ITC.** This is an excellent model to build upon and if integrated with the AEZs and proposed Food Parks and Secondary Agriculture industries, it can help stimulate rural economy beyond any rural planning that has been envisioned so far.

The RISC concept emphasized, and TACSA is in full agreement, that India's economic growth and development is predicated to a large extent upon the development of its 700-million strong rural populations. Bringing 100,000 people in villages in a circular cluster as suggested in the report by Gupta (2002), is consistent with the RISC model of development, and if such clusters are based on agro-based industrial development they can be self-sustaining. Currently, majority of India's population lives in almost 600,000 small villages and are engaged primarily in agriculture and related activities. This very large labor force in agriculture has very low per capita income and due to small land holdings agriculture is becoming non-sustainable activity to support their livelihood. Hence, a substantial portion of India's current agricultural labor force has to move to non-agriculture sectors or in to agri-based industrial sector. The challenge is to manage the transition of a large segment—perhaps even 80 percent of the rural population from a village-centric agricultural-based economy to a city-centric non-agricultural economy, and to do so in a reasonable period. For details of the RISC model of organization, see (<http://khoslaventures.com/>).

4.1b Comparative Picture of Rural Infrastructure in China

In contrast, the rural infrastructure in China has surpassed any one's imagination. China has estimated that more than 55% of its population will live in cities by 2020, 60% by 2030. Some 300 million to 400 million new inhabitants will leave the countryside to settle in cities in the next 20 years. More than 15 billion square meters of housing will be constructed to accommodate these new urban dwellers, equal to the European Union's entire current building stock, built in just 15 years.

China constructs more than 2 billion square meters of floor area annually—higher than any other country in the World. Every year, housing construction consumes 20% of China's steel output and 17.6% of cement production. China's gross domestic product per capita is expected to reach US\$3,000 by 2020 (US\$10,000 in terms of purchasing power parity). China is building massive skyscrapers, highways, city expressways, subway lines and an intra-city light rail. It has expanded the Beijing airport and building the second one, improving water, electric, gas, and heating facilities. And now, all across China, the equivalent of a city the size of *San Francisco* is being built every two weeks. In 2007 alone, Shanghai (with 17 million people) has completed towers with more square footage than all the buildings of Manhattan (USA) combined.

China has recently launched a rural initiative for over 800 million citizens. It plans to spend over \$11 billion a year on rural education, irrigation and medical services. **It is investing tens of billions to build 180,000 Km of rural roads—enough to circle the globe four times over.** Those who are interested is comparing progress in India vs China need to see this link for the Beijing Airport (<http://www.youtube.com/watch?v=Fd6mwQC8lwK>) and compare it with Delhi airport that is under renovation. The scale of undertaking for rural development in China is unprecedented in any nation building, and as a result China has not only become “the manufacturing country”(surpassing USA in 2009 for 18.5% of total world manufacturing output), but is in the process of transforming agriculture processing industries to supply all value-added goods to the World at highly competitive prices.

China made this transition in less than 20 years and has not only developed the “Advanced Manufacturing Platforms”, but also reinvigorated the farm economy by building new bioprocessing industries at the rural level. China

currently exporting many food ingredients to USA and Europe and deriving secondary high-value products like hyaluronic acid, biotin, coenzyme Q10, deoxycholate, pectin, agglutinin, enzymes, etc. for the international markets. No such products are made in India and all are imported. This revolution is rapidly transforming the country from a developing to a developed nation in a record time and this industrialized capitalistic approach is likely to result in political changes with time, making it more democratic. It is in fact cheaper and easier to set up a new industry in China today than in India due to many regulatory issues and infrastructure superiority, including the availability of more trained manpower. The imports from China are even flooding the Indian market and these imports now include even the agro produce, and the trade of China with India is rapidly increasing. This is affecting the Indian industries and making Indian products non-competitive even within Indian market. A lesson may be learned from this fast and unprecedented development as India has to compete with other countries in the open economy. Success in this endeavor will depend upon how efficient and competitive Indian industries, including agro-industries, can become.

4.2 Agriculture Education and R&D

Investments in R&D by any nation are directly linked with its prosperity and progress. The primary body for education, research and extension in the field of agriculture is the Indian Council of Agricultural Research (ICAR), established in 1929. India's transformation from a food deficit to a nearly food-sufficient country is largely due to ICAR's efforts in accessing, adapting, and improving new variety of seeds and the transfer of farm technology from the laboratory to the field. The seed production (breeding, distribution and hybrids) has now been taken over by the private sector, and a successful seed industry has developed in recent years. **Hence, the mission of ICAR needs to be refocused to address secondary agriculture: value addition to primary agriculture.** This would require further increase in primary agriculture to provide inputs for processing and value addition. Therefore, the overall role of ICAR would increase in this process. ICAR institutes are clearly capable of taking such a role provided a clear direction and resources are made available.

The skills and knowledge of farmers and other agricultural professionals need to change to take full advantage of bio-based economy (Swisher and Fields, 2000). These changes make it

necessary to re-evaluate educational programs in agriculture to specifically address the question: What are the competencies required of graduates of schools/colleges of agriculture to meet the challenges of new industries? Agriculture graduates will require knowledge and training in bio-based products processing and marketing. In addition, agriculture engineering needs to understand the complexity of new technologies and machineries, which must eventually be manufactured in the country. It was shocking to see the poor state of Agriculture Engineering when some TACSA members visited the Sugarcane Institute in Lucknow, UP. The state of their genetics and microbiology units was equally poor, while at the same time the entire administrative unit was being renovated with granite floor, an example of misplaced priorities. How such an institute can lead the nation in adding further value to sugarcane, a very important crop?

The need for trained manpower for this industry would be very significant. This need can only be met by modifying current curricula in agriculture universities to emphasize value-addition beyond production of food grains, fruits and vegetables. If agriculture is treated as an industry than basic business principles have to be taught to agriculture graduates, including marketing and sales. Agriculture engineering must include bioprocessing technologies and design of plants. A brief survey of the agriculture curricula in agriculture universities shows the urgent need of introducing a variety of relevant courses that address food technologies, processing of agro-byproducts for value addition, food safety, marketing etc. In this context, close collaboration with US universities as was done during 1960's to develop seed industries, may prove to be very productive, as it will save time and money to introduce the needed changes in the agriculture curricula.

The agriculture universities need to develop curricula that include agribusiness education and value-chain. It is the universities that need to show the way to the industry similar to what they did in primary agriculture. Starting from universities, private sector seed industry in India is now fast growing with several successful examples. This example needs to be followed in secondary agriculture to demonstrate to the farmer that further two to three-fold value can be added to their primary produce. Graduates (in partnership with academia, industry and government), must focus on macro-examination of key drivers, perspective of conversion technologies, commercial applications and market needs with focus on value-addition to

agro-products. The new curriculum in agro-bio-processing and bio-products need to be developed as soon as possible, including extension services (Shukla and Kumar 1995).

The bio-based product curriculum is unique, as it must be designed to interface with an on-line database offering students real time data concerning outputs, business trends, statistics and other vital functions in understanding the complex and ever-expanding bio-based products industry, in addition to the practical training on bio-processing. The course development in the use of information system to produce and market bio-products and disseminate information/knowledge concerning the scope and potential of agro-based products must be designed to serve all undergraduates to graduate students. It is high time that India begins to use its IT expertise to revitalize its own systems and procedures rather than continue looking for foreign companies out-sourced jobs. The job at home is much bigger and needs to be done as fast as possible.

Such modern curricula, if adopted across the entire ICAR system, would provide highly cost-effective method of training students in the newly developing area of agro-bio-processing and product development. The databases and courseware needs to be developed in consultation with few NRI scientists and further build and utilize the databases started by the secondaryagriculture.org. Availability of trained and knowledgeable employees is vital for the state and regional agencies and the private sector to undertake any bio-products manufacturing and marketing.

Indian agriculture education needs innovation. As pointed out by Honorable Prime Minister and several reputed scientists the quality of science education and research in India is at a decline (Balaram 2002, Jayraman 2007), a trend that must be reversed. Money alone is unlikely to solve this problem; able leadership, productive international collaborations and clearly defined goals with transparency and accountability in the entire system with time line for delivery, can generate the desired results. Only science-based and result-oriented programs need to be pursued avoiding as much as possible political interference to gain long term benefits from this endeavor. All institutional funding must become project-oriented and the system of seniority needs to be replaced by merit-based compensation.

TACSA recommends setting up a Task Force for Agriculture Education Reform to meet this

urgent need to build Secondary Agriculture-based Industries in the country. It does not mean that crop production, protection, and variety improvement work should stop, but rather **emphasis needs to be placed on value addition, so that farming remains a productive and self-sustainable venture for small farmers.** The curricula revision must extend to KVKs to provide opportunities of such learning at the rural levels. This provides significant challenges for the ICAR and the Department of Agriculture to train a new cadre of graduates to meet the demands of changing face of agriculture World over, and particularly to meet the needs of India for building competitive primary and secondary agriculture industries.

4.2a Information Technology and Remote Agriculture Education

The use of information technology to impart training has become a vital resource for providing inter-disciplinary fact-based up-to-date training to students. These tools need to be applied to improving agriculture education and training students that can deal with new generation industries in India. Agribusiness, biotechnology companies, power and electric companies, information technology, food processing, chemical and many other inter-related businesses all have a major stake in the bio-based product economy. Therefore, workforce development and creative linkages with new sources of human and technological capital are essential for the full development and success of the secondary agriculture in the country. It is essential that graduates in agribusiness and agriculture in general, be knowledgeable in this newly developing sector both for teaching, producing and marketing of agro-based products.

Only new graduates trained with modern agriculture curricula may help propel agri-industries forward. The risk in this venture is almost negligible because the need exist and the supply of students is unlimited. Most young generation students are choosing IT as a profession because other options are limited, and if profitable agro-industries develop quickly, the manpower flow would occur in this direction.

The use of information and communication technologies (ICTs) would enable reaching the unreachable anywhere in the country any time and at a very low cost. Large masses of youth could be trained through employment-oriented education programs. The use of remote education such as being practiced at the Indra Gandhi Open University and MS University in

Nashik, can prove to be very effective to transmit crash courses to millions of students across the country. ICAR has realized that there is need to develop such learning resources. However, effective exploitation of this media requires exposing faculty and scientists to ICT and to develop need-based entrepreneurship-oriented programs. Faculty and scientists need to be trained to develop resources using multimedia, web-based technologies and in transmission and retrieval of digital resources. Access to digital learning would enhance quality of teaching, education and research across all NARS institutions and would link Indian agriculture with the World. Extension of this knowledge to the farm level can revolutionize the Indian Agriculture. Clearly new funding would be required for this effort but these funds need to be utilized in a much more focused manner than those have been spent on NATP and AHRD programs in recent years.

Extension services need to be strengthened and communicated via television and radio channels. Both Doordarshan and All India Radio (AIR) needs to be set up for educating the farmers and showing them how they can increase farm inputs and get maximum benefit from their produce, by not only increasing the output of agriculture but also by value-addition to primary produce. This activity is essential since extension service is very weak or non-existent in most areas of the country. A Public-Private partnership needs to be explored for the extension services. M. S. Swaminathan Foundation has made some use of Internet technology to deliver a variety of information (including weather information) to farmers in remote villages. Use of e-chaupal and other internet-based media would help the young entrepreneurs to see how agriculture can be a profitable and exciting venture.

4.2b Role of National Research Institutes

Farmers need help from agriculture extension people, a service that was well developed in 1960's and 1970's in India but during the last 10 years it has dwindled as many extension jobs lie unfilled in states like UP which is the bread basket of the country. For the new farm and processing technologies to reach to farmer, skilled extension people are needed and which are in short supply, even if all existing positions are to be filled. Motivating field-workers and providing results-based rewards can change this. The national research institutes need to focus on technologies needed to develop agro-based industries and to make these industries internationally competitive so far the technology inputs are concerned. Israel and Australia have

developed a host of technologies to solve a variety of problems for farmers and agro industries, and as result these countries are rapidly advancing in this area. The same is the case with New Zealand and now with China and South Korea. Whatever technologies developed by CSIR institutes such as CFTRI and CMAP and others needs to be marketed to the rural people rather than waiting for them to come to the institutes in search for such technologies. The fact that "Research is Business" must be fully realized and communicated to each scientist with specific goals to achieve, and such accomplishments need to be properly rewarded. The simple goal needs to be "Develop new Industries based on technologies using agro-bioresource as input."

4.2c Other Institutional and Technological Constraints

Indigenous Technologies: While ICAR institutes were primarily responsible in developing new seed germplasm and agriculture practices that brought about success in green revolution, these institutes have not been very successful in adding further value to agriculture commodities and build new products and technologies for empowering the farmer (Sharma and Poleman, 1995). This may be that the scientists were never challenged to do so. Hence, the question needs to be asked why this gap has evolved in the three decades while it was supposed to be narrowed during this period. A satisfactory answer to this question would help find the solution, as scientists are clearly capable in their respective disciplines, but making them work co-operatively to solve a problem, is a matter of leadership and organization. In light of the fact that the quality of Indian research is declining (Balram, 2002; Jayraman 2007), simply increased funding for science education and research alone will not help, rather accountability and reward system must be integrated in a transparent manner across the entire agency to allow new innovations. Despite the existence of Agriculture management Institutes, a clear understanding of the transition from primary agriculture commodities that India is producing to secondary agriculture products that the country needs, has not yet occurred.

A survey of the major projects that are currently being undertaken at various ICAR and CSIR institutes (www.secondaryagriculture.org) revealed that there are very few projects and patented technologies that currently exist at these institutes that can make any significant impact on building secondary agriculture agro-

industries in India. The fact that none of these institutes have been able to give birth to a single new industry solely based on their technology, is a matter of national concern, although they have been providing some help to Indian industries, particularly during the last 10 years. Many Indian industries are currently looking abroad for new technologies and collaborations to make them competitive in this area. Clearly the needs of Indian industries are not being met by the indigenous technologies to develop agro-based products. The same was the case with telecommunication, electronics, pharmaceuticals and automobile industries, and only when new technologies were allowed to come in the country, a rapid transition occurred. Agriculture needs to follow the same path to build new agro-industries to compete in the open global economy and to empower farmer to get maximum value from their produce.

International Technologies and need for Collaborations: From farm tools to food processing and packaging plants, there is an urgent need to upgrade the equipment and technologies. Many international agro-based companies are keen to enter the vast Indian market to develop new products and services. In the agriculture sector, this potential is even larger as value-addition to agro-products can significantly increase agriculture GDP by two to three-fold. **TACSA suggests building collaborative ventures with international companies to bring new technologies in the country and develop agro-based products for both national and international markets.** This is not likely to happen fast enough based on indigenous technologies, as was the case with other industrial technologies. Only when new technologies and manufacturing processes were introduced the telecommunication, electronics and automobile manufacturing changed.

A technology transfer program needs to be initiated in each area of secondary agriculture, selecting the best international industries willing to partner with the Indian entrepreneurs to build World-class industries based on agro-bioresource available in each state. If such companies are located in rural area close to proposed AEZs and Food Parks this will generate significant new jobs and stimulate rural economy. For such an activity, it is essential that sufficient Government incentives be provided to the new industries to locate in rural areas. A complete deregulation of this sector is needed assuring that the farmer is not exploited in this process.

4.3 Marketing of Agro Products

In today's consumer-driven economy and fast-paced life the role of marketing is more important than manufacturing a product. In fact, most International companies spend as much on marketing, or more, as on manufacturing for many consumer products. Agriculture marketing is very limited in India. Marketing and sales are two distinct functions, however, they are often mixed in India and the roles and responsibilities of each player are not well defined. **The agencies that are supposed to be building marketing strategies are busy in selling the agro-commodities.** This activity directly competes with the private sector and is counter-productive for building industries creating jobs and helping the rural society to move forward and become self-reliant.

The involvement of NAFED to promote marketing of consumer items all over India like edible oils, processed foods, spices, tea, basmati rice, pulses etc. (valuing Rs. 59 crores and distributed directly to the consumers and to the institutions) is completely unnecessary as it can be easily handled by the private sector. Moreover, using Government resources and competing with the private sector is counterproductive in the open economy, as all costs of the NAFED are not factored in their operation. NAFED needs to focus on marketing of value-added primary agro-commodities where the private sector is weak. The fragmented intervention of NAFED in the consumer markets is evident by its involvement in procuring and marketing products, such as eggs, valued at only Rs. 1.5 crores. Other fragmented, unnecessary and completely unjustified (based on business models) activities of NAFED include acting as the Corporate Agent of IFFCO-TOKIO General insurance (ITGI), for a business of only Rs. 12 crores. It also provided marketing support to the tribal's and handled 378 MTs Niger seed procured from the tribal's valued at only Rs. 0.67 crores and 09 MTs Kacholam valuing Rs. 0.07 crores. These activities need to be performed by the small business and NAFED can encourage them to handle such commodities by providing them grants, if needed.

The government must allow free markets in agricultural commodities. When markets left to the private sectors they can create more value-addition and hence generate more jobs. Free market economy brings greater openness, increase efficiency, expand markets, and demand for new resources, materials and goods

create jobs and grow the size of overall economy. All inter-state transport of agri-products should be completely open and the freight of produce may be subsidized to reduce the cost to overcome regional short falls and to ensure year round supply of most fruits and vegetables across the country. This would also prevent waste of seasonal fruits and vegetables as they can be easily transported to other parts of the country at a reasonable cost.

The latest move to allow private mandis is a step in right direction. The entire grain and other agro-commodities procurement system needs to be privatized to ensure efficiency and prevent wastage that occurs at a large scale in the current procurement process. But similar to public monopoly, private monopoly also is not good for the society. Government should set a window of farm commodity support price to serve as a safety net during the transition to the market and the role of the Government must be to provide regulatory oversight and ensure fair play, rather than getting involved in the transaction of goods.

Dramatic reforms are needed in the area of agricultural marketing. There is an urgent need for a major overhaul in the legal framework dealing with product markets, including Agriculture Produce Marketing Committee Act, Essential Commodities Act, restrictions on processing and retailing, and the like. Unless all these bottlenecks are eliminated, major private sector investments in agro-industries are difficult to attract and sustain, and the growth in high-value agriculture will remain a hostage to high risks associated with any new undertaking.

4.4 Regulatory Environment

To build thousands of secondary agriculture industries across the country covering a broad range of products and services based on agro-bio-resource, it is essential that the regulatory environment be looked upon from the eyes of a farmer (rural person) rather than an industrialist. This fundamental difference must be realized in order to deal with the rural sector and a fragile (limited) infrastructure, which makes it very difficult to build an industry if the regulatory environment is not friendly and favorable. The Ministry of Industrial Affairs needs to open regional offices in each district to help register small companies and learn the language of "How can I help you?", rather than, "You can not do this or you can not do that", a common language generally encountered when dealing with any Government office. Creating a single-window clearance for building such industries and

providing business-friendly environment to facilitate this process would encourage much of the unorganized food processing sector to become organized and new agro-based industries will developed. The following steps may be considered to facilitate this process:

1. Create a simple form for registration of any agro-based industry with a flat fee for registration. Allow district level any agriculture agencies to perform this task.
2. Make the same registration form available on the web (on-line).
3. Give these new companies 5 years break to develop without any taxes, except collecting the payroll tax. It is surprising to see how many employees are paid their salaries in cash in India.
4. Allow all agro-based industries to import used equipment for processing and testing, including farm equipment, without any custom duty.
5. Provide space for such industries to be located near Food Parks in AEZs.
6. Develop basic infrastructure of roads and electricity in a cluster-based approach. Provide all essential services on a fee-based system.
7. Allow these industries to develop before regulating them and ensure that they are not over-regulated.
8. Simplify the regulatory process by making it transparent, holding each party responsible with defined steps to be followed in a time-bound manner and predefined penalties for failure.
9. Provide financial help as a grant or loan directly from one office at the district level, making the rules of the game simple and minimizing the chances of irregularities.
10. Provide incentives to build such industries and make payments only when the project is completed.
11. Create Technical Support Centers in close proximity of these industries where Extension services and crop/soil test facilities can also be made available.
12. Provide market linkage for agro-products acting as an information conduit (not becoming involved in buying and selling of products).

4.5 Potential of Secondary Agriculture in India

Secondary agriculture has unlimited potential – ranging from growing new crops and producing organic farm produce, including medicinal plants, to manufacturing of various products like starches from cereal grains, proteins from

legumes and oils and oleo chemicals from oleaginous crops. These are building block to formulate processed foods, materials, fiber and fuel systems as well as offer services based on developing these products. It increases the competitiveness of the Indian agricultural industry and creates new global business opportunities for the rural sector.

The secondary agriculture is a highly complex area, as it involves old and new technologies, investments, and the improvements in rural infrastructure, availability of power and changes in Government regulations. It also requires full cooperation of institutes and building bridges with international companies for transfer of appropriate technologies and building marketing links. If successfully implemented, however, this change can add 100's of billion dollars to the Indian economy and create millions of new jobs making a fundamental transformation in rural life, which has so far not occurred in any significant way over the last 60 years.

While a significant potential exists, India is not able to fully tap its agro-resource and build bio-based economy. A clear understanding of this issue is required to make appropriate changes in Government policies and bring together financial and technological resources together in order to turn around this scenario. There are two paths, which are not mutually exclusive, and both needs to be followed. One way is to build small scale rural industries based on locally available bioresource and technologies in a clustered manner. The second approach is to tap this potential is to build World-class companies in direct collaboration with international companies or licensing state-of-the-art technologies and installing the right equipment to make the high quality cost-competitive products for the national and international markets as China has done. To be competitive at the global level, World-class industrial platforms have to be developed for each category of products that can be emulated by others to spur additional activities to fill the void.

The list of current agro-based product in India (see Section 3) and its comparison with the list below of products generated in the West, suggests that the potential in this area for India is enormous as it involves a wide sector of the economy. The range of products that can be, and should be, derived from the primary agriculture is indeed very large. This includes

by-products from grain, sugarcane, fruits, animals, marine and other bio-resources. Some activities do exist in this area, but the level of these activities is very small and most of the technologies used are primitive to make it difficult to compete with China and other developing countries, let aside the developed countries. The rate of growth of agro-industries in India in 2005 was about 6% while that in China was 35% while the ranking of agro industries is 3.8 vs 26.5% according to the UNIDO data.

Bio-based products and companies span a broad range of industries affecting a significant portion of the economy. This spectrum is likely to be widen as new bio-based technologies evolve and pressure to shift from fossil fuel to renewable resource-based products grow internationally (Saeidy2004; Dan and Arvizuv, 2006).

Major categories of food and non-food secondary agriculture products include:

- Absorbents/adsorbents
- Activated carbon
- Adhesives
- Agricultural chemicals
- Alternative fibers/bonded fabrics/textiles
- Bio-based fuels such as ethanol and bio-diesel
- Gases/methane/CO₂
- Bio-plastics/polymers/films
- Construction and composite materials
- Biofilters
- Panels, Laminates, Composites, Hardware
- Cleaning chemicals, surfactants, soaps, detergents
- Enzymes, biologicals
- Foods, beverages, nutrients
- Fuel additives
- Fertilizers, phytochemicals
- Inks, dyes, pigments
- Landscaping materials/ soil amenders
- Lubricants/rust inhibitors/functional fluids
- Oils, waxes, binders, stabilizers
- Packaging materials
- Paints/coatings
- Personal consumer items/cosmetics
- Phytochemicals & nutraceuticals
- Soil remediation, biofertilizers and biocides
- Solvents & co-solvents
- Specialty chemicals, fatty and acetic acid, Sweeteners
- Paper & paper products
- Water & wastewater treatment products

Some of these products are being made in India in a very limited manner, while large scope of building major industries based on new technologies and innovations exist. The CSIR institutes may focus on these categories of products to develop new technologies or adopt technologies that are already developed in other countries to help build such industries in India. Judging from the current list of technologies available at various ICAR institutes (Alam et al., 2000) and CSIR institutes that were visited by TACSA members, very little scope exists for industrial development. This is a fact that no industry has ever been developed by technology spin-off from any National Institute in India, while thousands of such industries are being developed in Europe and North America as a direct spin-off of research from academic institutes. The following table provides a list of some products that can be easily made in India, out of which some are currently being made but at a very small scale. The technologies needed may be available at ICAR and CSIR institutes provided they are willing to devote time and efforts to deliver such technologies to the private sector.

Table 3: The potential of India to develop new secondary agriculture industries making the following specific products for the national and international markets

1. Grain Products/Byproducts a. Vitamins b. Enzymes c. Solvents d. Glutelin e. Animal feed f. Soy products
2. Sugarcane byproducts a. Alcohol/butanol b. Fiber Board c. Cardboard d. Paper e. n-triacontanol (Plant Growth regulator)
3. Food processing byproducts a. Limonene b. Resveratrol c. Wines d. Antioxidants e. Whey protein f. Waxes g. Natural dyes
4. Animal byproducts a. Enzymes b. Proteins

c. Rendering d. Gelatin e. Bone charcoal f. Sphingolipids g. Deoxycholate h. Hyaluronic acid i. Bone charcoal j. Hydroxyapatite k. Poultry feed
5. Marine products a. Agar, Agarose b. Chitin, chitosan, glucosamine, beta-carotene c. Fish gelatin d. Omega-3 (fish oil) e. Phytostimulants f. Alginate g. Biocompost
6. Biomass-derived products a. Cellulose, cellulose membranes b. Xylose, glucose, lignin, D-ribose c. Biogas d. Ethanol/Butanol e. Chemicals
7. Fermentation Industries a. Industrial enzymes b. Diagnostic enzymes c. Analytical enzymes d. Vitamins e. Amino acids f. Therapeutic proteins
8. Medicinal and aromatic plants a. Pure herbs b. Herbal extracts c. Phytochemicals d. Nutraceuticals e. Cosmeceuticals f. Fragrances g. Aromatic oils
9. Alternative crops a. Biofuel crops b. Wood crops c. Floriculture d. Horticulture e. Essential oils f. Fiber crops
10. Other bioresource a. Hair and feather (cystine) b. Urine (urokinase, Conjugated steroids) c. Phytoinsecticides d. Microbial Media e. Coconut Carbon f. Tobacco waste (Coenzyme Q)

g. Natural Dies h. Biopesticides/Biocides i. Biofertilizers
11. GM Crops for producing industrial enzymes and chemicals a. Biodegradable Plastics b. Phytoremediation c. Industrial Enzymes d. Chemicals e. Industrial oil
12. Other Related Industrial Industries/Products a. Honey bee farming b. Vermicompost c. Organic farming

4.6 Financing Agro-Based Industries

Availability of finances is the second most important constraint after the infrastructure. Venture capital being practically non-existent in agro-industries, often people depend on small loans and personal funds. The cost of financing, when available, is high, which includes interest, as well as loan fees paid to Bank Managers or Financial agencies. The capital investment is often very small and hence primarily small-scale industries are developed. Major investments by large business houses (venture capital) in this sector are almost non-existent. Recent interest in fresh produce is attracting some investments, but it is too small to make any major impact. Hence, Government needs to invest in this sector as a venture fund based on the SAIF (Secondary Agriculture Innovation Fund) model presented in this report. If the regulatory environment is eased and made transparent, significant amounts of national and foreign investments can flow in this sector.

In addition to the support proposed by SAIF as venture funds, NABARD needs to take an active role in financing such industries and Government may provide additional support to NABARD, specifically for the secondary agriculture ventures. The fact is that significant funds are available within the country and people are willing to invest, but they are afraid of the Government regulations, bureaucracy and have no clear direction where to invest in the agro sector. **Creation of a Government-ensured Agro-fund where public can invest and such fund can then invest in new agro ventures would be most effective under the current situation in India.** With out a massive investment, large-scale industries with new

technologies producing World-class products cannot be developed.

The need is so large that no single vehicle can pull this weight; hence, a variety of financial formulations to meet different needs of this sector would be required. Professional fund managers should handle this activity with Government providing guaranty to deliver confidence to the public in such investments. Government should not directly manage such funds. A significant infusion of foreign funds may also occur in this sector if the liberalization of agro-industries occurs and confidence in this sector is built.

In the USA almost 70% of the new startup businesses fail, but those that succeed some of them make very big returns. The risk of failure of companies in India is much lower, primarily because it is a "pull (consumer)-driven" economy as opposed to "push (corporation)-driven economy in the West where competition is much higher. Increasing demand of the consumers has to be met either by producing products within the country or importing them. This provides great opportunity for building new industries in India. Being largely an unorganized sector, public investment in agriculture area has been almost non-existent. However, if Government support and assurance is provided, public funds can become available for this sector.

In a pull-driven economy chances of success are much higher provided there is right technology and infrastructure is in place. Hence, secondary agriculture industries can succeed in a big way if there is a co-operation between the Government, Industry and the scientific Institutes, to build a model of success as Ireland and New Zealand have done. Without such cooperation, it would be difficult to see a meaningful growth in this sector during the next decade. Countries like China will fill the void created, as it can supply almost any product at a very competitive price. If this opportunity is missed, the cost of building such industries in India will be so high and job situation in rural area will be so bleak that it would be difficult to manage. And in the end the cost of not doing may prove to be higher than the cost of doing, i.e., building the Secondary agriculture industries. This view is also shared by FICCI, which is interested to see that this sector develops rapidly in the country to improve the rural economy.

A greater awareness of the potential of industrial agriculture biotechnology sector is needed

among the investment community in order for funds to be made available more easily for new ventures. A new investment model will be required which is between loans and conventional private equity, to provide finance along with equitable risk sharing. In this aspect, the help from Government would be vital to stimulate such industries in India. As the industrial agriculture technology sector becomes increasingly successful, venture capital will become more easily available.

To make full use of current technologies, access to global markets and to employ private investments both from Indian business houses, foreign companies and NRIs, a highly coordinated effort is needed at the national level, as this activity is interdisciplinary and has to deal with various sectors.

Role of NRIs: Non Resident Indians (NRIs) have very strong emotional ties with their motherland and are constantly endeavoring for a better industrial climate in the country. They possess very high degree of technical skill vis-à-vis managerial & business acumen and are in a commanding position to make financial investments (with highest per capita income in the World) and technical contribution practically in every field to help build the Indian industries, including agriculture. **This enormous resource (estimated to be over \$50 Billion) must be tapped while available.** The recent real-estate boom in the country was partly responsible for the NRIs investments in India. Dr. Suri Sehgal, a NRI member of TACSA, and a distinguished figure in the global seed industry established a foundation in India in 1999 (the Sehgal Foundation) and more recently established an Institute of Rural Research and Development (IRRAD), located in Gurgaon, Haryana, with focus on water resource, management and integrated rural development. (See for more NRI activities:

http://www.nriinternet.com/NRIschool/USA/A_Z/C/Manjit_Chinnan/index.htm).

To facilitate the participation of NRIs in Indian economy, the Government of India has made some changes in this area but bureaucratic impediments remain. The following changes have been made:

Non Resident Indians/Persons of Indian Origin/Overseas Corporate Bodies may invest up to 100 per cent equity in high priority industries. Such proposals will receive automatic approval provided:

1. The industry in which investment is to

be made is one of the specified industries.

2. The foreign equity covers the foreign exchange requirement for imported capital goods, which must comprise of plant and machinery, which should be new and not second hand. *This needs to be changed to all new and used equipment since even the major players in India are importing used machineries, and such machineries are essential for agro processing industries*
3. The outflow on account of dividend payments is balanced by export earnings over a period of seven years from the commencement of production in the case of consumer goods.

The diversity of industries that can be, and need to be developed in secondary agriculture area, and to empower the farmer to take part in the growing economy of India, requires cooperation and collaborations between the public, private and the Government.

A clear example of how cooperation between Government, Industries and academia can be seen from the recent boom of Life Sciences related industries in Ireland, and within last 10 years this small country has become a beacon for the entire pharma and biotech industries attracting hundreds of leading industries. The same has been achieved in fruits and vegetable

processing sector by New Zealand. Much can be learned from these examples, if China is not the right comparison, in the minds of some in India, due to political differences. It may be emphasized that it is easier today to open a company in China than in India and support it with World-class infrastructure and trained manpower. This is the reason that China will become by 2009 the number one manufacturing country surpassing even USA where 18% of the World manufacturing currently taking place.

Secondary agriculture development cannot wait building of technologies by Indian institutes, which has not yet happened in last 60 years. Hence, similar to other sectors such as electronics, automobile, telecommunication, much of the technologies needed to build above industries have to be imported as farmers are running out of time and these industries must be developed to provide much needed products/services as well as create jobs in the rural sector.

The only practical solution to this complex problem is to treat agriculture as an industry, deregulate it, and help farmers with financial, technological and marketing inputs so that more value can be added to the basic farm commodities, both via primary processing of food as well as secondary processing for non-food items. Such a transition will open a host of opportunities and will create millions of new jobs in the rural area where such agro-based industries must be located. This initiative needs to be taken in a "mission mode" operation.

5

GLOBAL AGRICULTURE TRANSFORMATION

World agriculture is going through a new wave of rapid transformation driven by new technologies and more open global markets for both food and non-food agri-products. The latter is being also fueled by the need for more non-petroleum-based renewable (Dan and Arvizuv, 2006) sources for chemicals and fiber materials and thus spurring new environmentally sustainable industries. It is noteworthy, that major global industries such as Dupont, Dow, Monsanto, BASF, BP and even GE have selected life sciences and naturally derived products as their engines of corporate growth for the 21st century.

Bioprocessing industry is well developed in most Western countries and is rapidly developing in Asia. In United States Agriculture has produced industrial products from food stocks even before the World War II, including medicines, inks etc. New techniques/tools of genetic and bioprocess engineering now enable economic improvements in feedstock utility and manufacturing systems.

Increasing environmental problems, including air and water pollution and global warming are associated with industrial processing of fossil fuels and burning of agro waste such as rice straw. Meeting market demands and building preference for bio-based products and bio-energy, is gaining support World over.

The life science revolution is about migration of the manufacturing industry from nonrenewable resources to renewable, solar based biomass, creating new, distributed sources of feedstock and a new industrial base. India has a unique opportunity at this time to build this in real time as the rest of the world is trying to shift from its existing infrastructure to the new infrastructure. The following resources, processes and

products are the focus of the green technologies:

Biomass Utilization

- Trees (Poplar, Paulownia, Eucalyptus)
- Grasses (Switch grass, Miscanthus)
- Agricultural Alternative Crops (Sesbania, Paulownia, Pangomia)
- Agricultural Residues
- Animal Wastes
- Municipal Solid Waste

Processes

- Enzymatic Fermentation
- Gas/Liquid Fermentation
- Acid Hydrolysis/ Fermentation
- Gasification
- Combustion
- Co-Firing

Products

- Fuels: Ethanol, BioDiesel
- Power: Electricity, Heat
- Fibers and Composites
- Chemicals: Plastics, Solvents
- Pharmaceuticals Chemicals
- Phenolics
- Adhesives
- Furfural
- Fatty Acids
- Acetic Acid
- Carbon Black
- Paints
- Dyes, Pigments, and Ink
- Detergents
- Food and Feed
- Enzymes/proteins

5.1 Bioconversion: Challenges and Opportunities

During the past decade, pattern of agricultural production has shifted in the world in such a manner that most of the countries around the

world are not self-sufficient in the production of all food fuel and chemicals. One reason for this shortfall is the lack of availability and the higher cost of energy that is required for various agricultural sectors. The improper utilization of the various agriculture byproducts that otherwise may prove to be a major source of revenue to the farmers or other relevant industries, is very limited. Thus there is an urgent need of alternative sources of fuels that could be generated from renewable resources. The U.S. government has set the goal of tripling U.S. use of bio- fuels by the year 2012. This is projected to create \$25 billion a year in new income for farmers in USA. The U.S. government has set the goal of tripling U.S. use of bio-fuels by the year 2012. This is projected to create \$25 billion a year in new income for farmers in USA.

As the population pressure grows, sustained economic developments are vital to secure supply of raw materials as inputs for manufacturing of a variety of products. The importance of bio-based products in the global economy is expected to increase significantly in the next two decade and India can certainly be a strong player in this emerging activity.

The use of agricultural raw materials in bio-based revolution to manufacture chemicals, bio-energy, plastics, and other new products, is being fueled by a wealth of knowledge about novel conversion processes, new technologies, and innovative product applications. A Science Roadmap for Agriculture (2001), prepared by the National Association of State Universities and Land-Grant Colleges (NASULGC) and Experiment Station committee on Organization and Policy in USA (ESCOMP), emphasized the development of a technical information base for use by producers, shippers, exporters, rural communities, government agencies, and universities for informed decision making. The need in this area for India is not only for investment in R&D to develop the bio-based industry, but also to collect, sort and disseminate information/knowledge about the scope and potential of bio-based products to public at-large. This activity can begin immediately under the existing institutional infrastructure and will have an impact on building secondary agriculture industries in the country.

A wide variety of bioresources is available for conversion into bio-products. Bio-products are generally defined as non-food, non-feed agricultural products that are used in a variety of commercial/ industrial applications including bio-fuels such as ethanol, butanol, methane and a variety of industrial chemicals. While agriculture

is primarily focused on food and feed production, forestry contributes a variety of materials as lumber, paper pulp and medicinal plants, and biomass production for biofuel industry is becoming a new agriculture activity (Singh 2007). Even in the biofuel area, the attention is shifting from grain and sugarcane-based ethanol production to lignocellulosic biomass-based biofuel production. In this context a new crop is emerging which consists of two species of Paulownia, a fastest growing softwood tree, to provide sufficient biomass to fuel the ethanol and butanol plants. Switchgrass is also holding some promise in this regard. Six million Paulownia trees have already been planted in US, Panama and Europe and a number of distillation plants are under construction using this bioresource as a feed for fermentation. Scientific developments are rapidly allowing changes in the relative contributions of agriculture and the chemical industry to increased use of renewable inputs.

Lignocellulose is the major structural component of woody plants and represents a major source of renewable organic matter. Agriculture waste such as wheat straw, wheat bran, rice straw, rice husk, oat straw, bagasse, corn cobs, corn stocks, wastes from fruits & vegetable processing plants, cotton hulls, cotton seeds, paper waste etc. contribute significantly to the renewable biomass. A study conducted in Punjab revealed that 2.5 Million Tons of paddy straw is burned every year to clear the fields for wheat cultivation (Tata Energy Research Institute). Such activities not only waste this important bioresource but also create environmental pollution, and must be stopped.

Cellulose, hemi cellulose and lignin are basic components of lignocellulosic residues. The huge amount of lignocellulosic waste is generated through forestry and agricultural practices. Organic acids and amino acids used as food additives as well as chemical feed stocks. Gluconic, Lactic, Itaconic, and Glutamic acids are important examples. Most of these chemicals are currently imported in India. Some are manufactured chemically but they are not sufficient to fulfill current industrial demand. All these organic acids are produced by microbes through various metabolic pathways and fermentation processes can generate these compounds. Sugar from various types of agriculture wastes (whey, molasses and bagasse) can be converted into organic acids if efficient technology is developed for producing these ingredients. The following areas need a focused activity.

Global Renewable Energy Picture and the Status of India: About 40% of the total energy

consumption is dedicated to transports and in practice requires liquid fuels such as petrol, diesel or kerosene. These fuels are all obtained by refining petroleum. Hence biofuel is a practical alternative to oil and has been used successfully by several countries like Brazil. The use of ethanol in Brazil has provided foreign currency savings of USD \$65 Billion over the last 25 years. If interest on foreign debt is considered the amount goes up to USD \$118 Billion.

OECD countries supply 21.8% of world renewable while consuming 49.8% of world total primary energy supply. On the other hand, OECD countries account for most of the production, producing 86.3% of wind, solar, and tidal energy in 2004. Renewable accounted for almost 18% of the global electricity production in 2004, after coal (40%) and natural gas (close to 20%), but ahead of nuclear (16%), and oil (7%). Almost 90% of electricity generated from renewable comes from hydropower plants while close to 6% comes from biomass renewable.

The Global Renewable Energy Policies and Measures Database compiled by IEA (at <http://renewables.iea.org>) include policies and information on 78 countries. The objective of this database is to provide a platform for enhancing awareness and knowledge of renewable energy policies and measures to provide basic statistical information on countries' progress. It also strengthens the capacity of policy makers and stakeholders to develop new energy-related policies. IEA has embarked on a comprehensive program to identify best practice and policy options towards a "clean, clever, competitive, energy future for the member countries.

In the Integrated Energy Policy Report of the Government of India (2006), the policy for Renewable and Non-Conventional Energy Sources was outlined. This policy emphasized the biomass-generated energy producing portable energy, ethanol, biodiesel, and biogas. The following specific points were included:

1. Capital subsidies that only encourage investment without ensuring outcome should be discontinued.
2. Power Regulators must encourage utilities to integrate renewable energy into their systems.
3. The energy being central to all developments in rural area, the Ministry of Power and the Ministry of Non-conventional Energy Source need to better co-ordinate the rural

electrification programs and the newly developed Village Energy Security Program.

4. The price subsidy for renewable is justified in this report, and such subsidies are particularly important for the biomass-generated electricity either through biodiesel or ethanol production.
5. The green fuel should be free of taxes as opposed to petroleum-based fuels as has been done in many western countries.
6. Employment generated in cultivating bio-plantations should be made eligible for coverage under the National Rural Employment Guarantee Scheme. Such plantation is eligible for carbon credit as well, benefiting the farmer.
7. Biodiesel production from residual industrial oil produced as a byproduct while refining edible oils, should be encouraged. Currently a duty of 65% is imposed on the use of residual industrial oils. This should be reduced to 5% at par with the crude oil, passing the benefits directly to consumers.
8. Support may be provided for biofuel crops, such as toxin-free *Jatropha* varieties, Karanj, and other such species with incentives until this industry becomes well developed. A Workshop conducted by TACSA on Feb 1, 2008 to bring together all stake-holders of *Jatropha* propagation and processing, showed that the economics and productivity of *Jatropha* are not as favorable as originally suggested as this crop also requires water and nutrients for full productivity and the breakeven point in terms of returns may be 10-15 years rather than 5 years as originally envisioned. Moreover, *Jatropha* contains several toxins and no toxin-free variety is currently under propagation. So, much research work is needed on this crop before it is pushed out in the fields for mass plantation.

Faced with the competition for land for food vs biofuel, the entire biofuel program in India is suddenly put on hold (Aug. 4, 2008, Sushmi Dey & Rajeev Jayaswal, ET Bureau). While canning of grain-based biofuel production or cultivation in competition with food crops may be justified, the conversion of lignocellulosic biomass for biofuel offers great potential and is in no way in competition with the food chain. Such programs need to be encouraged both for R&D and

industrial development. Many countries now acknowledge this fact.

5.2 The Bio-Economy of Europe

The dimension of bio-based industries is very large as it includes all industries and economic sectors that produce, manage or make use of biological and agriculture resources including agro-waste. The European bio-economy has been estimated to have a market size of over \$2 trillion, employing more than 22 million people. A recent report by Europe on industrial application of biotechnology and agriculture has put forward policy proposals to encourage the development of a Knowledge-Based Bio-Economy (KBBE). It was emphasized that data gathering, collation and analysis is the most important task, which underpins the whole process: “good policy cannot be formulated without good data”. At the same time, a comprehensive roadmap is needed to chart the way to allow both coherent implementation and impact evaluation.

As emphasized in their report “the synergies between various participating sectors, stimulating public-private partnership and industry participation in general, promoting interdisciplinary R&D, and to avoid fragmentation or duplication of programs”, are of paramount importance. This cooperation must also extend downstream to the demonstration projects, in particular to enable the development of R&D pilot plants to validate the concept of integrated bio-industries.

A necessary prerequisite in this process is the assurance of a secure and affordable supply of biomass, for which a combination of policy, co-operation and financial incentives would be required. All these issues are fully applicable to Indian context.

In brief, to establish a sustainable and knowledge-based bioeconomy in Europe, it is concluded:

- To establish a coherent Policy Agenda for Industrial Biotechnology and the Knowledge-based Bio-economy (KBBE),
- To stimulate and support innovation in plant (agriculture) science and industrial biotechnology,
- To promote production and use of bio-based products and processes,
- To create awareness amongst all stakeholders, and
- To improve investment in KBBE-related small to medium size enterprises.

Benefits of a Knowledge-Based Bio-Economy: The bio-based industries span across many areas and affect a vast sector of the economy. Some of the apparent benefits are:

- Food with improved nutritional value, increased food safety,
- Improved animal feeds, improved health.
- Energy and water-saving production and processes in agriculture and industry; decrease dependency of fossil resources; reduced production of greenhouse gasses. Sustainability and a cleaner environment
- Support for rural development: Use of “set-aside” land; cultivation of new crops; decentralized production facilities in rural areas.
- Increased industrial competitiveness through innovative bio-based products.

5.2a Food, Feed, Fiber, and Fuel (4F) Sector in Europe:

The following data provides the dimension of agro-based industries in Europe which is very large (over \$2 Trillion/year) and as these countries move away from fossil fuel-base to greener renewable base of production, the share of agriculture in total economy will grow.

Table4: Dimension of agro-based industries in Europe

Sector	Annual turn-over (billion €)	Employment (million)	Data source
Food	800	4.1	CIAA
Agriculture	210	15	COPA-COGECA
Paper/Pulp	400	0.3 direct (4 ind.)	CEPI
Forestry/Wood industry	150	2.7	CEI-BOIS
Industrial Biotech.	50 (est.)		McKinsey*
Total	1610	22.1	

Current applications of secondary agriculture and bio-based economy and forecasts in Europe:

- 50,000 tons bio-plastic was produced in 2005 in Europe.
- In 2005 Bio-based chemicals represents 7% of the market (\$77b in value) – in 2010 is it forecasted the cover 10% (\$125 b in value)
- Increase of biofuels in transport to 10 % by

Europe is showing a clear leadership in this area realigning industries with academia and Government to take full advantage of this emerging trend. EU has proposed a variety of initiatives to build knowledge-based bio industries:

- Promoting research and market development for a Knowledge-Based Bio-Economy.
- Ensure a sustainable contribution of modern biotechnology to agriculture.
- Foster competitiveness, knowledge transfer and innovation in life sciences.

The European budget for Life sciences and biotechnology for sustainable non-food products and processes is \$1.9 billion over 7 years (2007-2013). The following is an example of projects that are being supported.

Table 5: EU BioEnergy Projects

Topics	Instrument	Content
Pre-treatment of lignocellulosic biomass for ethanol production	CP small or medium	Lignocellulosic ethanol
New and advanced technologies for hydrolysis and/or fermentation of lignocellulosic biomass	CP small or medium	Lignocellulosic Ethanol
High purity syngas cleaning technologies for biofuels	CP small or medium	Synthetic biofuels
Biological conversion of syngas into liquid Biofuels	CP small or medium	Synthetic biofuels/biochem
Forest-based biorefinery	CP-IP	Forest-based biorefinery
New uses for glycerine in biorefineries	CP small or medium	Biodiesel-based biorefinery
Developing biorefinery concepts	CSA various	Various concepts

Table 6: EU Projects on Non-Food Products

Topics	Instrument	Content
PLANT CELL WALLS - Understanding Plant Cell Walls for Large CP optimizing Biomass potential	Large CP	Lignocellulosic ethanol
GREEN OIL - Plants providing oils of the Future	Large CP	
FOREST PRODUCTS - New forest based Products and processes	Large CP	Forest-based biorefinery
BIOPOLYMERS - Biological Polymers from Plants	Large CP	Biopolymers
LIGNOCELLULOSIC ENZYMES - Development of cellulases for lignocellulosic biomass pretreatment	Small CP	Lignocellulosic enzymes
LIPID ENZYMES - Development of enzymes for lipid	Small CP	Lipid enzymes

modification and activation		
DESIGNER ENZYMES - Improved biocatalysts for bioprocesses	Large CP	Generic processes
IMPROVED MICROBES – Metabolic engineering and modeling	CSA	Generic Bioprocesses

The 64% of the world's enzyme-producing companies are located in Europe. They meet about 75% of the global demand of enzymes.

5.2b Biochemicals, Biomaterials and Fuels (USA)

A report "Bio-based Products and Bioenergy Road Map – Framework for a vital new U.S. Industry" envisions a tenfold increase in the use of bio-based products and bioenergy in next two decades. According to USDA the number of bio-based high-technology startup companies in USA has gone up from 200 companies in 2000 to over 800 companies in 2007.

A wide variety of industrial products, including biomaterials, fuels and bio-chemicals are already manufactured from bio-based raw materials in Western Countries (see below). Bio-based chemicals used for commercial industrial products derived from biomass feed stocks, include: solvent additives, lubricants, adhesives, and inks. In addition, chemicals, enzymes, pharmaceuticals, plastics produced from biomass are only few of this group of products. In India there are hand full of such industries, such as Glycol India that produces chemicals directly from Sugarcane juice.

Biomass is an attractive energy source for a number of reasons. Biomass provides the opportunity for increased local, regional, and a major step towards national energy self-sufficiency. Transportation fuels made from biomass (biofuels) through biochemical or thermo chemical processes include, ethanol, methanol, biodiesel, butane, and methane.

Biomaterials: A wide variety of agriculture biomass resources are available for conversion into biomaterials. These may include whole plants, plant parts (e.g., seeds, stalks), plant constituents (e.g., starch, lipids, protein, fiber), processing byproducts (distillers' grains, corn soluble), materials of marine origin (e.g., chitin, sea weed, etc), and animal byproducts (e.g., viscera, blood, skeleton, horn, etc). These resources may be used to create new

biomaterials, but more typically they will be processed for use in bio manufacturing. This will require an intimate understanding of the composition of raw materials – whether it is whole plant, constituent, or byproduct – so that desired functional elements can be obtained for biomaterial production. While new technologies and processes are developed, simple production of products currently available in other parts of the World will generate significant industrial activities in this sector.

Conversion of agro-based raw materials into biomaterials will entail process design, system optimization, and model development and thus will involve many CSIR and ICAR scientists as well as import of certain technologies. Examples include biopolymers, biopolyols, adhesives, resins, food/feed ingredients, etc. helping create a variety of secondary agriculture industries.

Between 1999 and 2004, the worldwide production capacity for biopolymers grew significantly, to about 250,000 tons per year. Within Europe, recent figures indicate that consumption has increased from 20,000 ton in 2001 to 50,000 ton in 2004. By 2015, this consumption is expected to increase to about 1 million ton. Moreover, the long-term substitution potential of biopolymers is estimated at up to 15 million ton within the EU, a capacity that would meet about one-third of present plastic production.

5.3 Global Agro-Industries Forum

The first Global Agro-Industries Forum (GAIF) was organized recently in New Delhi from 8 to 11 April 2008 under the FAO and the United Nations Industrial Development Organization (UNIDO). The forum brought together 500 senior representatives from ministries of agriculture and industries, other UN agencies, as well as agro-industry specialists and private sector food industry leaders.

The Union Minister of Agriculture, Consumer

Affairs, Food & Public Distribution Shri Sharad Pawar and the Director General, Food and Agriculture Organization of the United Nations (FAO), Dr Jacques Diouf stated that “a key challenge is to develop agro-industries and associated enterprises that are inclusive of smaller scale producers and processors and that also deliver better products at lower prices thus directly helping poor consumers.”

The Agriculture Minister described the organization of the conference as a timely initiative and expressed hope that the role of agro-industries in enhancing productivity and profitability in agriculture, employment generation and poverty alleviation, would receive requisite attention. Dr Mangala Rai, Secretary ICAR, stated that “we are very pleased to be working alongside FAO and UNIDO to host this Global Forum in India,” and “we are committed to supporting the development of competitive but fair agro-industries” in India.

Rapid globalization, market liberalization, and urbanization have created new opportunities for increased trade in agricultural and food products in national, regional and international markets, but they have also created challenges and increased risks, as explained by Dr. Daniel Gustafson, FAO Representative in India.

5.4 Potential and Problems of GM Crops:

The issue of GM crop has been much discussed in the last decade. Starting with the cloning of the first plant gene in late 70's (which was done in Prof. Verma's lab, than in Canada), 100s of thousand experiments have been done on plants and animals with no evidence of any intrinsic harm of GM technology, but small fear persists as no one can state that it is 100% safe, it is certainly 99.9% safe, so far as the plant gene transfer is concerned. Considering the benefit to risk ratio, in 2007, farmers in 23 countries planted genetically modified crops including Argentina, Australia, Brazil, Canada, Chile, China, Columbia, Czech Republic, France, Germany, Honduras, India, Mexico, Paraguay, Philippines, Poland, Portugal, Romania, Slovakia, South Africa, Spain, the United States and Uruguay. “Of the 23 countries, 12 were developing countries and 11 were industrial countries. The potential in the second decade of genetically modified crop commercialization (2006-2015) is enormous. In India starting from a little under 30,000 ha in 2002, *Bt* cotton in the country has grown to over

6 million ha, which is almost 90 percent of the total area under hybrid cotton in India (K. K. Narayanan, *BioSpectrum* 2007). While the total area under cotton has remained unchanged, the cotton production in the country has reached almost 3 million bales (170 kg) from 1.4 million bales in 2002. A number of independent studies, including one by the ICAR have shown that the farmer is earning at least Rs 3,000 more per acre by adopting *Bt* cotton technology, through increased production and savings in pesticide sprays. Pesticide usage in cotton, which used to account for a staggering 54 percent of all pesticides used in country, has seen a drastic decline, not to mention the environmental benefits. The most recent economic survey (2007-2008) shows that the production yield of almost all food crops slowed down to less than 1.5 percent in the period 2002-2007, way below the projected targets. The only notable exception to this trend was cotton whose production in the same period grew at close to 15-20 percent per annum.

The success of *Bt* cotton should have paved the way for such technologies in other crops. But, this is not happening. The regulatory approval system in India, instead of becoming simpler and streamlined with the *Bt* cotton experience, has become uncertain and more complicated. The shifting positions and the new and mostly unreasonable testing requirements have not only delayed the release of other technologies, which could be applied to many industrial crops. This situation is financially unsustainable, the danger is that it may dry up altogether and India may be left way behind in this technology as compared to other countries in Asia.

The GM technology for non-food crops needs to be treated differently than that for food crops, as these crops are used for fiber and industrial chemicals production. Industrial crops have become a major growth area with new crops on the horizon and existing crops being improved. New products produced from these crops are no longer just “natural,” they are now competitively priced and functionally superior. The product range of GM crops are enormous ranging from metabolites to biodegradable plastics. The ADM in USA has launched the first biodegradable plastic plant in the World in collaboration with Metabolomix in Germany. The GM crops will soon be producing better fiber, Industrial enzymes and novel metabolites offering great potential for India. There is nothing inherently wrong in the technology it self, rather it is the judicious use of technology and traits that are created which needs to be controlled and monitored for the benefit of the society. If

regulatory issues for GM crops are streamlined and simplified, the Indian companies can be competitive in this area as China has done successfully. A clear policy distinction needs to be made between food and non-food GM crops, and the latter needs to be promoted. The main danger of the spread of antibiotic resistance genes that has been used in selecting GM plants can now be avoided as new technologies are available that do not use such controversial tools.

The fact that crop productivity is declining and traditional methodologies are not yielding desired results, while other countries are moving forward solving problems of their crop improvement using desired technologies, is a matter of concern. China has GM crops with over 150 traits in the field and the desire of farmers in India to move forward in that direction is highlighted with the following communication from Secretary General, Consortium of Indian Farmers Association (CIFA):

Dear Friends,

Dt/ 20-08-08

Sub: Request to Bio-Technology Organizations & Scientists to assist to organize inter-action.

GREETINGS FROM P.CHENGAL REDDY SECRETARY-GENERAL, CIFA

www.indianfarmers.org

The problems confronted by the small farmers of India because of Crop losses due to Pests and diseases have reached Rs.60,000 crores. We are aware that Bio-Technology is the solution for many problems. The Public Sector Research in India is not able to find solutions due to various reasons. Commercial Research Companies have brought about much benefit to the crops of Cotton. The poor man crops as well as Commercial crops are unable to increase productivity due to non-availability of Hybrid seed or G.M.O. But due to the following reasons, the Indian farm sector is unable to take GMO forward.

- 1) Opposition by the Environmental Groups against introduction of GMO's in Food crops;
- 2) There is no GMO research in poor man crops of Pulses, Oilseeds etc., either by Private Sector or by Government.
- 3) No Institution to sensitize people on benefits of G.M.Os.

I am in Washington on the invitation of the World Bank to participate in their Annual Conference as representative of Civil Society Organizations (CSOs) from 7th to 14th October, 2008. (Letter copy enclosed)

I would like to meet stake holders of Bio-Technology to explain the needs of Indian farmers.

I will be grateful if you can acknowledge receipt of this letter and fix a suitable date any time after 15th October for the above purpose.

Awaiting for positive response.

With regards,

Yours sincerely,
(P.Chengal Reddy)
Secretary General CIFA.

6

BUILDING SECONDARY AGRICULTURE INDUSTRIES IN INDIA: OPERATION MISSION MODE

Indian financial institutions are very reluctant to invest in the agro-based industries due primarily to the poor infrastructure, unorganized procurement affecting the input supplies chain, lack of appropriate indigenous technologies and major investments required to build large internationally competitive facilities. A highly coordinated effort between the Government, R&D institutions and the private sector will be required to build these industries in the rural sector. Effective use of Information Technology (IT) will help in the operation of such industries, making them more efficient and competitive in the global markets.

A major infusion of capital by the Government to jump-start this industry in a **“mission mode”** would be essential. This Secondary Agriculture Improvement (SAI) mission is no less important than the Food Grain Mission that led to the “green revolution” and the Telecommunication Mission, two highly successful missions that have had major impact on India. While the impact of food grain mission is well known as it is feeding the entire country, the impact of telecommunication mission is also enormous as it has over the last 5 years resulted in delivering almost 300 million cell phones making India #2 in the World in cell phone usages. This is also impacting the rural economy as information flows fast and traveling need is reduced.

Similarly, a mission on Secondary Agriculture would revitalize the rural economy and it would have a multiplier affect on the entire economy accelerating overall GDP of the country. Therefore, any investment in this sector should not be considered as a simple help to farmers but rather a step to build the necessary leg of

the “Stable Economy”, **integrating rural economy into the current developments underway in the country.**

6.1 Operational Considerations for Building Secondary Agriculture Industries

Realizing the current state of affairs, and the need for co-operation between the Government and the private sector to facilitate building of such industries in the shortest amount of time possible, the TACSA suggests an innovative approach to facilitate building of the Secondary Agriculture Industries sector in the country.

1. The Planning Commission (PC) creates a Central Office of Secondary Agriculture (COSA) to coordinate all activities of Secondary Agriculture and to facilitate building of such industries across the country. If this is not possible, then a Department of Secondary Agriculture Technology (DSAT), along the lines of DBT may be created.

Role: Policy decisions, rules, regulations and Inter-ministerial coordination, and the linkage with States.

2. Regional Offices of Secondary Agriculture (ROSA). It is recommended that initially 4 regional offices be established in four regions, which can also serve to address specific local secondary agricultural needs.

Role: To link the states and provide Information and direction to regional

industries and help find appropriate technical and financial solutions.

3. An investment of \$2 Billion be made to jump-start this sector. This investment in the form of Secondary Agriculture Innovation Funds (SAIF), be managed by a special purpose vehicle to be placed under the Ministry of BioProcessing (see below).

Role: To manage and allocate funds to various ventures in different states via ROSA.

4. It is further recommended that the name of the current Ministry of Food Processing be changed to Bioprocessing to reflect both Food and Non-Food industries. The "Ministry of Bioprocessing" can co-ordinate SAIF activities. This organization must operate on a business model managed by professional venture funds managers and technologists to deliver the desired results.

6.2 Secondary Agriculture Innovation Fund (SAIF)

Proposed Structure of Secondary Agriculture Innovation Fund (SAIF)

(Special Purpose Vehicle for facilitating Secondary Agriculture Industries)

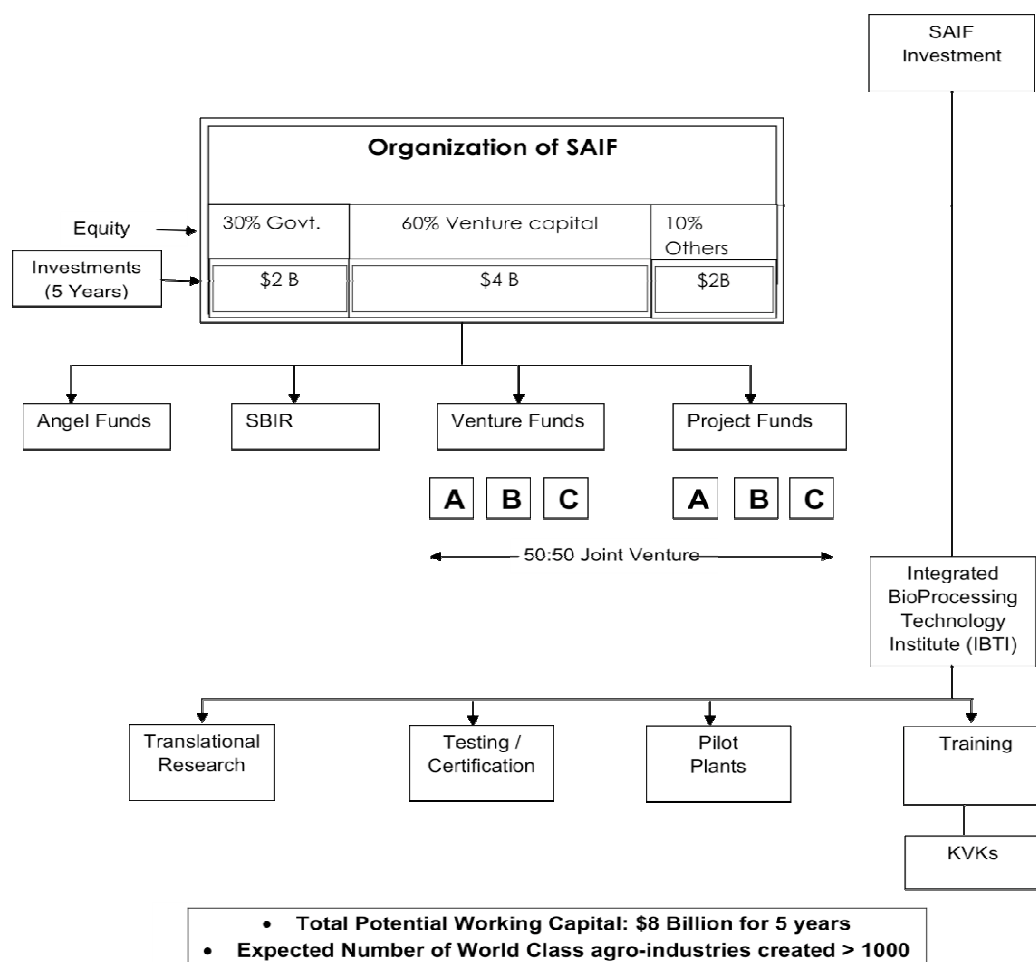


Figure 3: An organizational structure is proposed to achieve this objective. This structure needs to be developed with International norms strictly as a business venture supported by GOI (venture fund) as outlined here.

TACSA is proposing that the sum of \$2 Billion be invested by SAIF. The investment in SAIF is expected to be matched by other national and international venture funds in a ratio of 1:1, which would be invested in a further 1:1 equity partnership, making it an effective investment of \$6-8 Billion. These funds need to be invested as follows:

1. An investment of \$200 Million in developing the bioprocessing technology infrastructure, including building of an Integrated Bioprocessing Technology Institute. (IBTI).
2. An investment of \$100 Million to be coupled with private Angel Funds of \$100 Million for early stage concept development and proof of concept generation in specific promising bioprocessing technologies.
3. An investment of \$700 Million to be coupled with private VC funds for small company development (minimum of 1:1 matching and up to 1:4 matching of SAIF: Private Funds).
4. An investment of \$1 Billion for project financing – again coupled with private funds raised up to \$3-4 Billion.
5. SAIF should co-ordinate all logistics and act as an interface between the Central Office of Secondary Agriculture (COSA) and the Agro-Industries. Furthermore,
 - a. To interface with the industries at the state level, each state will eventually develop a Office of Secondary Agriculture (ROSA).
 - b. An organizational is shown above and the management of SPV is suggested as follows:

The Management Structure of SAIF may comprise of the following 16 key people:

1. Board of Directors with a chairperson being the Member of the Planning Commission
2. 4 people from Financial Organizations
3. 4 People from National Organizations
4. 4 People from International Scientific/Industrial organizations
5. Secretary of the Ministry of Food Processing
6. Secretary of Agriculture
7. Secretary DBT

The angel fund is a mechanism by which nascent concepts are tested, using small sums of money to determine if the concept is viable. This has both business and technical components. An investment of \$200 Million (half

from GOI) can essentially fund 200-500 companies as early stage startups establishing the feasibility of technology leading to second stage funding. The progress of such ventures needs to be very closely monitored with a time line approach.

The VC Fund with GOI as a limited partner in several privately managed venture capital (VC) firms shall be designed to jump-start this industry. The Government should only agree to invest in the VC firms if the VC firm is able to raise a minimum of \$50 Million for investments from private sources in the area of specific industries such as biofuels, biomaterials, bioprocessing, food and feed biotechnology, animal and aqua agricultural products, animal byproducts, etc. These funds are designed to develop companies, from pilot scale demonstration to full-scale ventures, understanding the business models, customer needs, managing intellectual property and having regulatory freedom to operate. This is essentially the “**company-creation model**” and each investment is expected to be in the range of \$5-10 Million. If a total of \$2 Billion is the sum allocated to VC funds, 200-500 companies could be established. With syndication, this number could be easily doubled. This, along with the seed companies, we can expect creation of almost 1000-2000 new small and medium size companies.

The investment of \$2 Billion is being recommended with the intention of building a \$20 Billion industry over the next 15-20 years. Such an investment enables India to significantly shift its imported, non-renewable resource-dependency to a locally generated, renewable system that is decentralized and capable of contributing to the rural economic and industrial growth. It will accelerate technology introduction into a segment of agricultural value chain, to create and capture new value as well as provide a framework for India to more productively deploy its precious land and water resources. Eventually it would allow absorption of rural people in to the mainstream economy of the country.

The project funding is designed to help the VC funded companies invest capital in building manufacturing plants, scale up of business models so that fully functional businesses could be established. This is a lower risk capital than the VC funded capital but is expected to generate a lower return than the VC funded capital. If \$40 Million is the average investment, **it is expected that for a total raise of \$4 Billion in this space, approximately 1000**

world-class companies could be build or expanded.

1. Small companies are usually the source of innovation; they have speed and are focused on execution as has been shown by many IT companies.
2. Private investors bring the fiscal and business focus to the entrepreneurs and can mentor the entrepreneurs.
3. Deal syndication augments quality and quantity of investments as all proposals go through extensive scientific and business scrutiny.
4. Global access to technology and global markets create "world class" companies.
5. Emulation of few success stories is likely to spur thousands of new companies in the country in this area.

Demonstration Platform: To build confidence and scale up the operation across the country, it would be essential to demonstrate that such a coordinated activity can give birth to new generation agro-industries in India. TACSA suggests that a demonstration platform be established in UP or Punjab, two major agriculture states, where a set of industries supported by SAIF be establishes along with the proposed IBTI (see below). The focus of this undertakingshould on cultivation technologies, processing, marketing of medicinal plants and horticulture products (as an example). Success from this can be emulated at other locations.

6.3 Integrated Bioprocessing Technology Institute (IBTI)

While 90% of the SAIF will be invested in various new bioprocessing ventures, a fraction of this investment should be made to establish an Integrated Bio-Processing Institute (IBI).

To facilitate development and transfer of technologies including pilot plants, co-ordination between the institutes, and building a marketing interface TACSA proposes to build a World-class integrated Bioprocessing Technology Institute (IBTI) in a Non-Governmental Operation mode, directly managed by SPV in close collaboration with industries. IBTI to develop, import, adopt technologies to meet the Indian environmental conditions with pilot plants capabilities, and build marketing interface nationally and internationally for various bioproducts industries can produce. This institute would have pilot plat facilities and modern processing equipment for providing state-of the art training as well as testing (certification), packaging and marketing

functions. IBTI need to work in close collaboration with existing ICAR and CSIR institutes.

This organization should become self sustaining after five years of initial operation and should run on a business model, recovering most of its cost of operation through business alliances with only training component being supported by Government grants.

Role: To become a World-class bioprocessing (Food and Non-food) institute with pilot plant facilities for facilitating transfer of technologies from national and international sources and adapting them to Indian conditions.

Location: Northern India (Punjab, UP or Haryana, the major agriculture belt). Considering that UP is now the bred basket of India surpassing Punjab in agriculture productivity, this institute may be located in UP.

Staff: An international team of experts in food processing and biotechnology sector. This institute needs to be run with business norms and not based on Central/ State Government rules of civil servants. Hence salaries need to be competitive with the private sector to attract the best people.

Budget: A minimum of \$200 Million would be required to establish such an institute with state-of-the art bioprocessing facilities.

IBTI will work closely with ICAR and CSIR institutes to build industry-oriented programs with direct participation of industries to ensure that appropriate technologies are developed or imported and indigenized to meet the needs of the industries and help them find international markets for their agro-based products. The IBTI main focus should include:

1. **Developing systems and technologies that utilize regional biomass to produce chemicals, materials, pharmaceuticals, nutraceuticals and value-added animal byproducts.**
2. **Catalyzing technology transfer and developing business models for establishing a bioproducts and bioenergy industries using agro resource; and**
3. **Establishing an international market link for Indian bioproducts. These three integrated components are currently missing in any ICAR or CSIR institutes, and hence they are**

not able to give rise birth to new industries, despite scientific expertise existing at these institutes.

TACSA suggests a following organizational structure for IBTI.

- Chairman of the Board
- Board of Directors
- Scientific Board
- Managing Director
- Project Evaluation Committees
- Managers of Different Departments
- Scientists
- Technicians
- Workshops Managers
- Support Staff
- Maintenance Staff
- Pilot Plants
- Training and Marketing Interface

6.4 Other Organizational Considerations

Changing the Mandate of ICAR Institutes:

The role that ICAR institutes have played in green revolution has resulted in building successful Seed Industry in the country. This success needs to be emulated for the Secondary Agriculture. Hence, TACSA believes that the mandate of all commodity-based ICAR institutes, such as Potato, Sugarcane, and Rice Research etc. needs to be changed to focus on value addition to each commodity. The research activity must be product and services driven rather than basic research, which is generally a domain of university research.

To strengthen the position of India in medicinal plants area, current five institutes of CIMAP, TBGRI, NRC-MAP and IHBT and the Medicinal Plants Board need to coordinate and work with one mission, i.e. to double the export of medicinal plants and their derived products in next 5 years. This can be accomplished by appointing an executive director to monitor and control the entire operations of all 4 institutes. For authentication of materials, both genetic and chemical certifications of any species/pure herb is needed. In addition these institutes must rescue the endangered medicinal plants species (Chaudhry 2007) within the next 5-year period. In this regard, the role of the Medicinal Plants Board needs to be more precisely defined. Although significant activity exist as many institutes claim to be doing work in this area but many species have yet to be rescued from the endangered list and brought under cultivation.

NMPB has set up 35 State Medicinal Plants Boards and has sanctioned 4254 projects under two major schemes, viz. promotional and contractual farming. A list of projects supported by the NMPB as described by Kala and Saijwan (2007) is provided in Appendix VI.

Import of Essential Equipment: It is apparent that due to cost considerations most of the Indian bioprocessing industries as well as training institutes are using mostly outdated and inefficient equipment. While warehouses of fully functional advanced used equipment are available in Europe and USA, Indian companies are not able to take advantage of this opportunity. Again, China is taking this advantage and procuring used equipment at a fraction of the original cost. To reduce the cost of major new equipments for bioprocessing and packaging plants, it is recommended that all used Farm and Bioprocessing equipments, as well as testing/research equipments should be fully exempted from duty and taxes. The apparent loss of custom duty on such imports will be more than offset by building the new industries which will generate better paying jobs and taxable revenues within 5 years, invigorating the entire agriculture sector. **The long-term benefits outweigh the short-term gains by custom duty on such imports.** Moreover, this may fuel new innovation in the manufacturing sector for building in India similar equipment to meet the unique requirements of Indian Industries. Without proper tools no product can be produced at a competitive price. It is no surprise that the import of the packaging machineries is changing the face of the food packaging industry and the consumer is willing to pay for convenience and safety.

Industry-Crop Relationship: Secondary agriculture industries can only develop in a crop-specific manner, as they would require significant inputs either from primary processors, agro-wastes or inputs from alternative crops. It is therefore essential that such industries be located in a clustered manner close to the AEZs and food parks, meat processing industries and where significant amounts of agro-waste is produced. For example, potato starch producing factory can only be placed in major potato growing area, such as in Bengal. The secondary agriculture industries to process non-food crops such as medicinal plants, jute bamboo, sugarcane byproducts etc can be located in areas of propagation of these crops to reduce the cost of transportation of raw materials. The medicinal plants processing industries need to be located near areas of production of medicinal plants in different climatic zones of the country.

Once the herb is processed in to a stable product (dry powder, or extract) it can be transported to another location for further value addition.

6.5 Federated Farmers Farms (3F) – “Ajadi Farms”

As the land holdings are declining and the farm productivity has reached a plateau, the Indian farmer has no choice left but to consolidate his/her land with others and build larger joint forms where necessary inputs can be provided and primary agriculture productivity can be increased to supply materials for further processing and value addition. The Federated Farmers Farms (3F) can provide ultimate freedom to the farmers and can be termed as “Ajadi Farms”, as they would provide a choice to the farmer to either work on the farm or find alternative profession. India has built various successful cooperative ventures among which Amul is a world-class operation in the milk sector. 3Fsystem can begin by contract farming to build trust between various parties followed by leasing the land to Ajadi Farm. Such an arrangement can actually increase the cultivated land as farms can be retained digitally using ISARO satellite maps, but abolish the boundaries to create larger farms and hence provide the economy of scale. The role of space technology in agriculture development was emphasized in a conference held in 2007 by FFA and APSRAC. The basic rules of such consolidation need to be worked out by each state under the guidelines of the Central Government. **Farmer must retain the ownership of the land at all time.** With such an arrangement, the farmer can be benefited in three ways:

1. Lease of land to the 3F Corporation (Ajadi Farm)
2. Paid for work at the farm or processing plant
3. Benefit from small equity in the “Ajadi Farm”

This is a win: win situation for all parties involved and the farmer will achieve ultimate freedom to explore other options if one does not want to work at the farm, a choice that farmer does not have at present.

The scheme of Mega Food Parks as proposed by the Ministry of Food Processing (see below), if linked with the secondary agro-processing industries can generate further value to the entire bioresource, building thousands of new industries and creating millions of jobs in the

rural areas. These parks can be closely associated with AEZs that are currently operating across the country.

Examples of new generation Successful co-operatives in Value-added Agriculture Ventures in USA: Examples of new generation, value-added successful agricultural businesses based on farmers co-operatives in USA. This shows how farmers can succeed provided they are given right tools and the regulatory environment. This model is also suitable to Indian farmers with smallholdings and in need of processing facilities for their produce. Such developments, however, require specific guidelines from the Government for the private sector to follow with financial help to set up the legal and operational framework.

6.5a Success factors for the new generation cooperatives

The above model suggests that such ventures can not only succeed but are necessary to bring the right technologies and markets together for getting maximum value from farm products. If a framework is developed and legal support is provided, such ventures can succeed in India as well because there is a need on the part of farmers and desire on the part of the investors to make such a bridge. In this Government needs to play a catalyst role and show how 3F system described above can succeed to provide sufficient agro-inputs for primary and secondary processing to get maximum value and pass some of that value to the farmer while widening the base of agriculture driven GDP.

- Local leadership
- Honest and open communications
- Realistic market-entry strategies and expectations
- Realistic goals and assumptions based on studies
- Sufficient member equity
- Comprehensive business plan
- Engineering and design of plants
- Capable Management without any political involvement
- Experienced consultants
- Focused marketing efforts
- Strong financial base
- Technical help from institutes
- Commitment to pooling resources
- Government help, legal and financial
- Inter-ministerial co-operation to make the project successful

Source: Dennis A. Johnson, St. Paul Bank for Cooperatives, USA

6.5b Federation of Farmers Association

The concept of cooperatives is not new in India as several successful ventures like Amul, exist as model organizations. Federation of Farmers Association (FFA), a Non-Governmental organization is working for the development of the farmers and agricultural sector to increase its share in the national economy and also to utilize the global opportunities. FFA is also creating awareness amongst farmers on Government of India incentives and encouragement of the participation of private Indian industries in rural development. In addition, CIFA (Confederation of Indian Farmers Association) carries out many awareness programs through out the country. The Department of Agriculture and Cooperation is implementing many schemes/programs to promote cooperatives in India for achieving these objectives.

6.5c Successful Indian Co-operatives

A World Bank project for the National Cooperative Development Corporation (NCDC) of India was designed to support the development of the Indian cooperative movement by strengthening the capabilities of the National Cooperative Development Corporation. The project was aimed to accomplish this through expanding the scope of its activities and extending its involvement into new areas in nine participating States. The project provides credit for a rural storage component, involving the construction of about 7,800 rural godowns in six States; a soybean production and processing component, involving the establishment of 800 Oilseed Growers' Cooperative Societies, together with soybean seed processing plants and solvent oil extraction plants in six States. The project also includes a cotton-processing component, involving the establishment of eleven cotton ginneries and five spinning mills in five States. Furthermore, the venture provides an institution building component, involving the establishment of Staff Training Institutes in six States, and development of a training program for staff of the rural godowns, processing plants, and cooperative agencies.

The cooperative sector has played a significant role in India in the area of disbursing agricultural credit, providing market support to farmers, distribution of agricultural inputs and imparting cooperative education and training. It is, therefore, considered imperative to design long-term and short-term strategies for reducing

economic disparities between the down-trodden rural people and the rural rich, as well as regional imbalances including rural and urban differences. Building co-operative enterprises is a right step to bridge these gaps.

Cooperatives in Under-developed States: In 2006, the NCDC made available financial assistance of Rs. 944 crores to the least/under-developed states for various cooperative development programs. During the year 2007, financial assistance of Rs 1923 crores was sanctioned and Rs 757 crore was disbursed by the NCDC to the cooperatives in cooperatively least/under-developed states/UTs under its different schemes.

Integrated Cooperative Development Projects: In order to promote the development of primary cooperatives as multi-purpose entities to provide a package of services to rural communities, the NCDC is implementing the scheme of integrated cooperative development projects in selected districts in rural areas. During the year 2006-07, eight projects (three in Rajasthan; three in Jharkhand; and one each in Haryana and Uttar Pradesh) at a project cost of Rs 82 crore were sanctioned involving the NCDC's share of Rs 76 crore (loan- Rs 61 crore and subsidy Rs 16 crore). During the same period, the NCDC released a loan assistance of Rs 766 crore and a subsidy of Rs 159 crore aggregating Rs 925 crore for these projects. Cooperatives are not suitable for all sectors of the rural economy and needs to be restricted to input and out puts in agriculture, rather than diversifying and micromanaging rural life on a pattern of extreme socialism system.

Cooperative Spinning Mills: In order to improve the economic condition of the cotton growers as well as handloom and power-loom weavers and to consolidate the gains achieved so far, the Department of Agriculture and Cooperation through the NCDC, continued to provide financial assistance to the spinning mills and ginning and pressing units in the cooperative sector. In 2006-07, the NCDC sanctioned financial assistance of Rs. 5282 crore (including a subsidy of Rs 769.61 crore) to four cooperative spinning mills.

Cooperative Education and Training: This scheme has been under operation since the Third Five-Year Plan and is implemented through the National Cooperative Union of India (NCUI) and the National Council for Cooperative Training (NCCT). At present, the Union is operating 45 projects. During the year 2006-07, up to December 2006, over 12,23,00 persons

were educated under the NCUI projects, as against the target of 14,84,000 fixed for the purpose. The NCCT conducted programs through its five Regional Institutes of Cooperative Management, 14 Institutes of Cooperative Management, located in different states, and the Vaikunth Mehta National Institute of Cooperative Management, Pune. The Government of India provides 100 per cent financial assistance in the form of grants-in-aid to NCCT for conducting cooperative training programs. The Council also provides academic and financial support to Junior Cooperative Training Centers, which are financed by State Cooperative Unions/State Governments.

The financial support earmarked for implementing the cooperative education and training programs during the year 2006-07 was Rs 65 crore including Rs 3 crore for the north-east region, Rs 40 crore for the Corpus Fund for Cooperative Training and about Rs 5 crore for Junior Cooperative Training Centers and Rs 0.07 crore for Centre for International Cooperation in Agricultural Banking under the re-structured central sector scheme for cooperative education and training.

The Scheme for Intensification of Cooperative Education in Under-Developed States including the Northeastern region is being implemented through the NCUI with 100 % financial assistance. The NCUI-run projects have been established at eight places in the North-east regions, namely, Aizwal (Mizoram), Bishnupur, West Imphal (Manipur), Jorhat, Kamrup (Assam), Kohima (Nagaland), Shillong (Meghalaya), and West Sikkim. These projects have made a tangible impact in improving the income of members of SGHs and cooperatives. During 2006, a significant number (71,175 persons) were imparted basic education and training by these projects.

Cooperative Development Programs through National Cooperative Development Corporation: The Government of India implements its cooperative development programs also through NCDC. The programs/schemes being implemented through this agency are: integrated cooperative development projects in selected districts; assistance to cooperative marketing, processing and storage etc., in cooperatively under-developed states/UTs; and share capital participation in growers/weavers cooperative spinning mills. The support includes a subsidy component provided by the Government of India and the loan component provided by the NCDC. During 2005-06, the NCDC sanctioned an

assistance of Rs. 3,170 crore and disbursed the highest ever assistance of Rs 2300 crore under various schemes and programs implemented. A net surplus was recorded by the Corporation at Rs. 14005 crore during 2005-06, as against Rs. 12,519 crore in the previous year. In the year 2006-07, an assistance of Rs 1658 crore in 2006 was disbursed by the NCDC against an approved outlay of Rs 1,800 crores.

Cooperative Storage and Cold Storage: The government is making efforts to assist through the NCDC, cooperatives in creating additional storage capacity, aimed at facilitating expanded operations of cooperative marketing and distribution of inputs and sale of consumer articles. Storage capacity, assisted by the Corporation and owned by the cooperatives, increased from 11 lakh tons in 1963, to 146 lakh tons by 2006. During 2006-07, the NCDC released Rs 487 crore (Rs 208 crore as loan and Rs 218 crore as subsidy) for storage programs. Similarly, during 2006-07, the NCDC released Rs 205 crore (Rs 162 crore as loan; Rs 1.00 crore as subsidy) under the cold storage program. These amounts are clearly inadequate for such a vital program to insure the proper storage, for value retention and value addition to agro produce. This is the most vital activity to minimize spoilage of fresh farm produce; hence extensive private-public partnership efforts are needed to make such facilities available near most fruits and vegetable growing areas. Cold facilities are also needed for the meat processing industry, much of which is in unorganized sector creating significant health and environmental problems.

Integrated Cooperative Development Projects for Rural Development: In order to promote the development of primary cooperatives as multi-purpose entities to provide a package of services to rural communities, the NCDC is implementing the scheme of integrated cooperative development projects in selected districts in rural areas. During the year 2006-07, eight projects (three in Rajasthan; three in Jharkhand; and one each in Haryana and Uttar Pradesh) at a project cost of Rs 82 crore were sanctioned involving the NCDC's share of Rs 76 crore (loan- Rs 61 crore and subsidy Rs 16 crore). During the same period, the NCDC released a loan assistance of Rs. 766 crore and a subsidy of Rs 159 crore with total of Rs 925 crore for these projects. Cooperatives are not suitable for all sectors of the rural economy and needs to be restricted to input and out puts in agriculture, rather than diversifying and micromanaging rural life on a pattern of extreme socialism system.

Organic Farming Cooperative: The Indian Farmers Fertilizer Cooperative Limited (IFFCO) has evolved as a federation of farmers' cooperatives, which produces fertilizers for the farmers. Like IFFCO, more cooperatives of farmers need to be formed, which can produce fertilizers. In other words, let farmers' cooperatives produce inputs required for agriculture and Government needs to stay out of such activities, only to provide help in formulating policies and any needed help to under developed areas, such as tribal areas. For this, guidance and training should be given to the farmers, particularly in organic farming, micronutrients, biofertilizers, biopesticides etc.

Revitalization of Cooperatives: With the expansion of cooperatives in almost all sectors, signs of structural weakness and regional imbalances have become apparent. The reason for such weakness attributed to the large percentage of dormant membership, heavy dependence on Government assistance, poor deposit mobilization of members, lack of professional management, etc. Concrete steps needs to be taken to revitalize the cooperatives to make them vibrant democratic organizations with economic viability and active participation of members. Some of the steps taken include the enunciation of a national policy on cooperatives, revamping of the cooperative credit structure and reforms in cooperative legislation for providing an appropriate legislative framework for a healthy growth of cooperatives. Again, cooperatives may not be suitable for certain sectors and such expansion must be based on market sustainability, rather than handouts from the Government. While new cooperatives are being developed, the non-productive and non-functional organizations must be closed down to take in to account the financial viability of such units.

A bill was introduced in 2006 to make the functioning of cooperatives autonomous, democratic and professional in nature and has been referred to the Standing Parliamentary Committee on Agriculture for examination and report. The current status of this bill is not known.

6.6 Agri Export Zones (AEZs) in India

India has established several Agri Export Zones (AEZs) across the country that has proved less controversial than SEZs because they have not resulted in a change of land use for industrial and other activities. AEZs are not fixed by physical boundaries like SEZs—they are regions in different states known for growing special

crops like gherkins, grapes, mango, lichi, potato, pineapples, Darjeeling tea, rose onion, vanilla, flowers, basmati rice, medicinal and aromatic plants, pomegranate, banana, walnut, garlic, spices, durum wheat, lentils & gram, cashew nut, honey, apple, ginger, turmeric, coriander and cumin.

A recent study of 60 Agri export zones (AEZ) spread across 20 states conducted by Agriculture and Processed Foods Export Development Authority (APEDA) shows AEZs are approaching the export target of Rs 10,685 crore up to February 2008 against the target Rs 11,821 crore. The investments by the central and state government agencies and by the private sector in the AEZs, however, have not been up to the mark. Against a projection of Rs 1,718 crore, the cumulative investment so far has been only Rs 1,098 crore. This amount is very little considering the scope and potential of this industry. Moreover, rather than focusing on exporting agriculture commodities, TACSA suggests that these zones begin to focus on how to add value to these commodities and get better returns both to farmers as well as the industries that can develop. For this a close co-operation of Food Parks and Secondary Agriculture Industries would be essential.

Andhra Pradesh with five AEZs has a record export turnover of Rs 2,853 crore. The AEZ for mango pulp and fresh vegetables in Chittoor district alone recorded an export turnover of Rs 2,736 crore, while export of mango and grapes in Ranga Reddy, Medak and Mehaboobnagar districts earned Rs 18 crore.

The gherkins AEZ in Mehaboobnagar, Ranga Reddy, Medak, Karimnagar, Warangal, Ananthapur and Nalgonda districts is likely to bring in Rs 44.5 crore through exports. The chilli AEZ in Guntur district earned Rs 51 crore in exports.

Kerala has two AEZs. Its horticulture products AEZ in Thirssur, Ernakulam, Kottayam, Alappuzha, Pathanamthitta, Kollam, Thiruvananthapuram, Idukki and Palakkad districts are expected to earn Rs 2,278 crore. Kerala's medicinal plant AEZ is yet to become operational.

Karnataka's AEZs could bring in Rs 1545 crore through exports. Its gherkins AEZ located in Tumkur, Bangalore, Hassan, Kolar, Chiradurga, Dharwad and Bagalkot districts registered an export of Rs 1,237 crore.

The onion AEZ in Bangalore and Kolar districts

earned an export amounting to Rs 276 crore, while its floriculture AEZ in Bangalore, Kolar, Tumkur, Kodagu and Belgaum districts earned Rs 32 crore. The vanilla AEZ in Karnataka is yet to become operational.

In north India, Punjab with its three AEZs has earned Rs 1,524 crore through exports. The basmati rice AEZ located in Gurudaspur, Amritsar, Kapurthala, Jalandhar, Hoshiarpur and Nawanshahar districts fetched Rs 1,521 in exports. Export earnings from Punjab's vegetable and potato AEZs have been negligible.

Maharashtra is the fifth state, which has done well in earnings from exports through AEZs. The state has eight AEZs for grapes and grapevine, alphonso mango, kesar mango, floriculture, onions, pomegranate, banana and oranges. The cumulative export earning from these eight AEZs are Rs 1,166 crore.

The APEDA review also noted that some AEZs are yet to become operational, like the Darjeeling tea AEZ in West Bengal, vanilla AEZ in Karnataka, lentils & gram AEZs in Madhya Pradesh, sesame seed AEZ in Gujarat and medicinal plant AEZ in Kerala.

From the above data, it is apparent that while the export of these basic agriculture commodities can generate some revenue for the country, and the middle man is happy, this amount can be increased three to four fold if further processing and value addition is carried out creating significant number of jobs and expanding the agriculture economy as China is doing.

6.7 Mega Food Parks

The Ministry of Food Processing Industries has proposed to implement a scheme to establish 30 Mega Food Parks in the country during the 11th Plan. The proposed Food Park could be implemented in already identified AEZ (about 60) or clusters identified by the National Horticulture Mission. The clusters could be mapped based on commodities such as fruits and vegetables, dairy, fisheries, animal husbandry, poultry, oil seeds, spices, wine etc. Such an approach can provide much-needed synergy among agencies likely to be involved in interfacing with the Food Parks.

The Food Parks can also facilitate organic farming and processing/packaging of organic foods. In zones which offer potential for organic

farming (Gauri 2005), exclusive food parks could be set up for organic produce processing and marketing. These parks can also serve as sourcing hubs for retail chains for fresh produce.

Although such parks were proposed during the 9th and 10th Five-year plans not much progress has been made so far. Moreover those plans were too small to meet the needs of the country. The new objectives of Mega Food Park are:

- Provide state-of-the-art infrastructure for food processing in the country on a cluster basis ensuring value addition of agricultural commodities including poultry, meat, dairy, fisheries etc.
- Establish a sustainable raw material supply chain for each cluster
- Facilitate availability and application of latest technology
- Provide interagency linkages for pooling of resources of activities complementary to food processing
- Quality assurance through better process control and capacity building
- Address issues of small farm size and small nature of processing industries through a cluster approach with stakeholders managing the supply chain.

The locations of Mega Food Parks have to be selected on the basis the agricultural and horticultural surplus available. A mix of products and crops has to be processed to increase the viability of the proposed Food Parks. The supply chain has to be clearly delineated and the points of On-Farm Primary Processing Centre/Collection Centers have to be established. All these can be done only by a professional management agency technically equipped to handle this task. A Special Purpose Vehicle (SPV) is proposed to be established to manage these Food Parks, supported by a Project Management Team (PMT) to ensure that all components are in place for the success of any project. This approach is consistent with the analysis and suggestion made by TACSA. Such approach would ensure the supply of raw materials for further processing of secondary food and non-food products out-lined in this report.

A centralized infrastructure is proposed to take care of the key processing activities, which require essential technologies like testing laboratories, effluent treatment, packaging etc.

that are capital intensive. Under the guidance of such parks, On-Farm Primary-Processing Centers (OFPPC) for processing of fresh produce and Collection Centers for aggregation of primary processed produce for transportation either to retail outlets or for the delivery to the processing units, need to be established. These could also act as a platform for technology feedback to address issues such as introduction of appropriate varieties for processing and handling of produce to meet the processing requirements of respective industries. These OFPPCs of operated on the e-choupal concept introduced by ITC (see <http://www.echoupal.com/>), can help farmers to meet all their basic inputs and social needs.

The Mega Food Parks Scheme proposes a financial assistance in the form of grants up to 50% of the project cost in most states and up to 75% of the project cost in special category states subject to a maximum of Rs. 50 crores or the cost of approved facilities, for all implementing agencies including private sector. The scheme provides for establishment of 30 Mega Food Parks with total MFPI financial assistance of Rs. 1500 crores during the 11th Five Year Plan.

Food processing industry is most developed in the West and various machineries exist for automation of different processes. Such machineries can be obtained as "Used equipment" at a fraction of the cost of new equipment. Indian fruit processing industries should be allowed to import such equipment at the face value to deploy new methods of processing and to rapidly develop the secondary industries generating jobs and adding value to this vital bioresource. Adding exorbitant custom duties on Book Value of such equipment is prohibitive for the growth of this industry in India.

6.7a Supply Chain Management:

The feedback from the food processing industry indicated a lack of reliable raw material supply as a major constraint. While supply chain management is important for all industries, it is of paramount importance for the food processing industry and for the development of secondary products. Farm production is relatively unorganized and this calls for appropriate backward linkages to be established simultaneously with establishment of processing facilities. Bulk of production of fruits and vegetables occur in small and marginal holdings. In such a situation, it is extremely essential to have aggregation of the produce at the village level itself before being transported to the park,

which is centrally located. In fact, the parks should be located near the concentration of farm production in light of the increasing cost of transportation.

For addressing this issue, appropriate institutional development at grassroots level, with involvement of small and marginal farmers is essential. The concept of self-help groups or Neighborhood Groups has been found effective in the food/ vegetable production system. Each group may comprise of 20-50 farmers. These groups can be the first point of aggregation of the produce, and can also act as an agency for transfer of technology for adoption of best practices to improve productivity and quality to meet the market needs. They can be empowered by establishing OFPPCs at Panchayat level. These organizations may be stakeholders in the Food Parks. The model has already been tried in the plantation sector and dairy sector with a fair degree of success. The situation with sugar mills where farmers stand in line for some times 24 hrs or more to unload sugarcane and then wait to collect the payments, must be avoided for procurement of farm produce by the Food Parks.

In the model for supply chain management, the fruit/vegetable producers' society/ association is the next suggested level for aggregation of the produce. Fruit/ vegetable producers' society/ association would be a cluster of 20-50 self-help groups (SHGs), which would also provide these groups with basic minimum facilities for handling the fruits and vegetables produced by its members. To facilitate aggregation of the produce, Collection Centre can be established at the block level. Apart from the SHGs, large farmers and village level traders in the identified zone also can serve as supply source of raw materials.

For food products supply chain traceability is important and such programs are in place in most Western countries and some Asian countries such as Korea are implementing such programs (<http://www.agnet.org/library/bc/54015/>), <http://agricoop.nic.in/AnnualReport0607/COOPERATION.pdf>

Around 20-50 such clusters may be organized in the service area of Mega Food Parks to ensure regular supply of raw materials to the parks. The same concept holds good for the poultry, and dairy sector while for the meat and fish sector a separate facility is required (See also meet processing section). The Mega Food Park will therefore have three tiers in the supply chain

(backward linkage) management.

- Producers' Groups comprising of 20-50 SHG (Each SHG: 20-50 Farmers) /Large farmers/village level traders in the zone- with On-Farm Primary Processing Center for cleaning, grading, sorting & Controlled temperature storage. About 20-50 such clusters may feed a Food Park.
-
- Collection Centers with pre cooling facilities depending on the need must be provided at these centers. These centers will have facilities for transfer of technology as well as information kiosks, supply of inputs etc along the lines of e-Chaupal. ITC is developing internationally competitive agricultural business by empowering the independent small farmers using this concept. The company is setting up a network of Internet-connected kiosks, known as e-Chaupals, through which farmers can receive all the information, products and services to enhance their farming productivity and receive a fair price for their harvest. Through the e-chaupal, ITC sources the farmer's produce directly, reducing its procurement and transaction costs. Currently 4300 e-Chaupals covering six states and 25,000 villages have been set up. By 2010, the e-Choupal network plans to cover over 100,000 villages, representing one sixth of rural India, and create more than 10 million e-farmers.
-
- Food Park (with common facilities)- Processing units

the Scheme. Alternatively, a Producers Company with the equity participation of SHGs/ Association (cluster), large farmers, traders etc. can be promoted by the SPV and the SPV can have equity participation in the Producers' Company.

Facilitating formation of SHGs of farmers will require intensive extension efforts. The SPV proposed by the MFPI to be formed for implementing the Food Parks may not be in a position to carry out this task directly. These functions can be discharged by the State Agricultural/ Horticultural Departments. Alternatively, NGOs may carry out this activity. The capacity building of the extension workers and providing technologists will be the responsibility of the SPV. The farmers' producer companies can also directly make arrangements for bulk supply of inputs, access to technology, organize programs for capacity building etc.

One of the major constraints in the Fruit and Vegetables sector is lack of good planting materials. The farmers' producer companies can address this issue. Nurseries can be run on a commercial scale including adoption of biotechnology and micro propagation techniques. Here the involvement of ICATR institutions to transfer appropriate plant propagation/improvement technologies would be valuable. An information kiosk shall be provided at the fruit/vegetable producers' society/ association level to deliver market information and input materials. Such kiosks can be linked with e-chaupal or similar digital platforms such as secondaryagriculture.org.



Figure 4: Supply chain link from Farm to Food Parks/ Retailers

The backward linkages in the jurisdiction of a park will be organized under an appropriate institutional arrangement- a Producers Company (registered under Section 25) or a Society under Charitable Societies Act. Under the proposed arrangement, it is estimated that approximately 5000 farmers may get directly involved in the supply chain.

This number needs to grow at least 10-50 fold to make a country wide major impact. The Producers Company or the Society will be a shareholder in the SPV formed for implementing

The institutional arrangement proposed would address the concerns raised in the context of contract farming by farmer organizations. The Producer Company can directly deal with entrepreneurs/ corporate investing in the park for the supply of appropriate varieties by changing the cropping pattern, if need arise. The Producer Associations also can enter into contracts with the retailers. While the demand for fresh products can be met through the primary processing/ collection centers, the demand for intermediate/ fully processed food products and secondary byproducts can only be met by the units in the park.

6.7b Basic Facilities to be Provided in the Food Parks

- The basic infrastructure like roads, water supply (bore well, water tower, power distribution lines, water treatment plant), sewage treatment shall be provided before placing any company in these parks.
- Administrative building, conference room, Business Hotel, Bank, Post Office.
- Wide banned Open Internet Access
- Electric sub station with dedicated power, Centralized Emergency Power Generation System
- Security Service/ Police Station
- Basic refrigeration plant with puff insulated panels
- Weigh bridge
- Freezers/cold rooms
- Pressure Ventilation
- Incubation Chambers
- IQF facility
- Variable Humidity Storage Facility
- Pre-Cooling Units
- Effluent Treatment Plant
- Packaging Facility
- R&D & quality control lab
- Marketing Assistance

6.7c A Review of the Food Park Scheme

The scheme to establishing Food Parks is in operation since 8th Five Year Plan with periodic revisions in successive Five Year Plans. Though the Ministry of Food Processing Industry (MFPI) has supported development of 54 Food Parks in the country during this period, most of them are yet to be established. Against a physical target of 25 Parks during the 10th Plan, 18 Parks have been sanctioned so far. Of these, only 8 Food Parks have been established. Even those established are facing problems of gross under utilization, besides being unable to attract entrepreneurs. Only 28 units are currently in operation in these 8 Parks. The cost of scheme so far has been much higher than if industries were directly paid to establish in a clustered manner.

Ministry of Food Processing Industries commissioned an external agency to carry out diagnostic study and evaluations of the Food Park scheme. It was point out that the State Industrial Development Corporations or PSUs implement the scheme in the traditional industrial estate mode with unsustainable

management and implementation arrangements. This has resulted in valuable real estate being acquired but only utilized at low levels of efficiency. The scope for commercial development of these locations for promotion of the food processing industry is yet to be utilized. Major reasons for the poor functioning of parks are:

- Location and site related problems including cost and unsuitability of locations:
- Delay in providing basic infrastructure facilities like power, water, road etc.
- Delay in release of financial assistance.
- Lack of entrepreneurial awareness, interest and aggressive promotional marketing efforts.
- Poor management and implementation capabilities.
- Absence of strong backward linkages.
- Weak linkages with the national markets and no linkage with the International markets.
- Lack of funding for components such as internal roads, drainage, environmental control facilities and solid waste management facilities etc, which are also important infrastructure needed in the park.
- An inadequate proposal appraisal system.
- Failure to identify the various components of the supply chain.
- The studies have also pointed towards the lack of a comprehensive project report from the raw material supply chain to the market, assessing infrastructure needs at every stage, defining rate-limiting steps, technologies and building market links was developed.

This study observed the need for providing higher scale of assistance for building infrastructure items in the pattern of like Industrial Infrastructure Up gradation Scheme (IIUS) under the Department of Industrial Promotion Policy, Ministry of Commerce and Industry, Textile Center Infrastructure Development Scheme and Scheme for Integrated Textile Parks (SITP) under the Ministry of Textiles and Scheme for Pack Houses, Cold Storages and Mobile Processing Units under National Horticulture Development Board, Ministry of Agriculture. These schemes carry higher rates of subsidy as compared to MFPI's Infrastructure Schemes.

The evaluation also suggested that the park will be successful only if infrastructure for (1) On Farm Storage (2) Primary Processing (3) Minimal Processing (4) Retail Outlet (5) Mobile Processing Unit (6) Mobile Pre-cooling Unit (7) Packaging Centre (8) Pellatization etc. are provided on a cluster basis, without insisting on all common facilities to be provided within the acquired area of the Park. In essence take the facilities to the growers/producers, and don't put the burden of transporting and supplying the materials to the processors, or rather let the processor collect from the producer providing maximum benefit to the farmer.

Revised Food Park Plan: In view of the experience gained in the implementation of the Food Park Scheme by the Ministry of Food Processing, and taking the recommendations of the evaluation studies into consideration, it is proposed that the Food Park Scheme should be revised/ restructured with the following objectives:

- Provide state of the art infrastructure for food processing in the country on a pre identified cluster basis
- Ensure value addition of agricultural commodities including poultry, meat, dairy, fisheries etc.
- Establish a sustainable raw material supply chain for each cluster.
- Support the deployment of latest technology.
- Provide interagency linkages for pooling of resources for activities complementary to food processing industries
- Quality assurance through better process control and capacity building at each participating industries
- Address issues of small farm size and small and medium nature of processing industries through a cluster approach with stakeholders managing the supply chain.

Cluster-based Approach: The Integrated Food Zones/ Mega Food Parks need to be selected very carefully on the basis agricultural and horticultural surpluses available. Infrastructure available for transportation as well as processing has also to be kept in mind. A mix of products and crops has to be handled to increase the viability of Food Park. The supply chain has to be clearly delineated and the points at which grading and processing units have to be established also need to be finalized. All these can be done only by a non-Governmental professional management agency specifically selected for this job. The SPV, to be established

to manage the Food Park, needs to be supported by a Project Management Agency to ensure that these components are handled most professionally.

In this scheme there is a provision for a centralized infrastructure to take care of the processing activities, which require cutting edge technology like testing laboratories, effluent treatment, packaging etc. which are capital and technology intensive. Under the umbrella of such a park, primary-processing centers for processing of intermediate products and even finished products with minimal processing can be established. These could also be a platform for technology feedback to address several issues such as introduction of appropriate varieties for processing and handling of produce to meet the specific industries requirements.

The Food Park can be established for any sector on need basis such as Fruits and Vegetables, Dairy, Meat & Poultry, Wine etc. Subject to feasibility, such centers can facilitate development organic farming and processing of organic food. In zones, which offer potential for organic farming, exclusive food parks could be set up for value addition and marketing.

The Integrated Food Zone/ Mega Food Park could be implemented in already identified AEZ (about 60) or clusters identified by the National Horticulture Mission/ Technology Mission. The clusters in the service area of the proposed park could be mapped (in all sectors such as fruits and vegetables, dairy, fisheries, animal husbandry, poultry, oil seeds, spices, wine etc) to evolve detailed implementation plans.

Project Implementation: As Park Projects are complex in nature and involve multi-disciplinary skills, it is proposed to appoint reputed and experienced consultants as Project Management Agencies (PMA), with experience in development and financing of industrial cluster infrastructure on PPP basis, to be engaged by the MFPI, requiring clear deliverables. The PMA's role will be from conceptualization to commissioning of the project including:

- Project development.
- Pre feasibility study.
- Facilitating formation of SPV, which is expected to be a corporate entity with users/ entrepreneurs having majority stake.
- Establishing linkages with agencies-government, non-government or international.

- Providing resources to support activities that are vital for the sustainability of the project, besides financial closure of the project
- Providing general advisory services to the Government and the SPVs for effective implementation of the project.
- The Park to be managed by the SPV which would be provided with operational autonomy so that they do not become surrogate Public Sector Enterprises or be controlled by Central/State Governments.
- SPV will be entrepreneur driven and will engage professionals to manage the day-to-day affairs.
- The main source of revenue to the park will be user fee. In case of loans availed by SPV for development of park, the repayment will be done by way of collecting the charges from the lessee of the facility.
- PMA will also suggest a risk management strategy.
- The SPV is to function as a nodal point for the skills and resources available in the project area and provide a mechanism for participation by farmers, processors, retailers and Government
- The cost of engaging the PMA is to be borne by the Government (in addition to the grant to the SPVs).

A few successful models with world-class technology to meet international quality standards with due importance to Sanitary and Phytosanitary Standards (SPS) and Hazard Analysis and Critical Control Point (HACCP) can act as foci for development and will facilitate auxiliary processing units. The higher scale of assistance and the additional expenditure on account of engaging the PMA will be more than justified by the degree of success this model can ensure. It is found that location of a few large units can encourage others to join and leverage the strengths of the park.

Action Plan: The ministry of Food Processing is proposing to set up 30 parks during the 11th Plan Period (at least two in North East). Seasonality of raw material availability and uncertainty of quality and quantity introduce much higher risks in the food-processing sector. The cost of establishing an Integrated Food Zone/ Mega Food Park is estimated to be Rs. 120 Crores. Considering the higher risk involved in food processing, the revised norms

propose that the grant from GOI for one park will be 50% of the project in General Areas and 75% in Difficult Areas limited to Rs. 50 Crores. Ministry will engage a Project Management Agency to assist the Ministry in the implementation of the project.

The out lay would include the fees for the PMA, cost of preparation of DPR, supervision charges for civil works and the cost of organizing SHGs/ neighborhood groups and their capacity building etc., to be carried out by NGOs or any other agency engaged to do so.

TACSA believes that this activity should be left entirely to the private sector, and Government should provide land on lease, road, water, electricity and core facility to be operated on fee basis. Governments should set general rules to be followed, rather than getting involved in building facilities and managing them where Government has often failed in the past. Let the private industries set up their own facilities.

The Government should fund the building of first model facility along with IBTI located in Punjab or UP, and the lesson learned from its success can be repeated at other locations in the country.

Estimated Impact

Investment

Investments of Rs. 120 Crores for the common infrastructure in each Park, can bring in a total investment of about Rs. 300 Crores. Thus providing a grant of Rs.1500 Crore for 30 parks can trigger an investment of Rs.9000 crore across the country.

Employment

Each Park is expected to provide direct employment for 1000 persons and indirect employment to 5000 persons. Thus the total employment to be generated in 30 parks is estimated to be 30000 direct and 150000 indirect (without taking into consideration the employment generated at farm level).

Farmer processor linkages

The proposed model can build farmer-processor linkages, which has been the key to success in food processing in countries such as Brazil. The suggested framework will also help in aligning the supply chain from 'farm to plate' to meet the requirements of the international market, introduction of sustainable standards and brand building. Parks can serve as sourcing hubs for retail chains to bring products to the markets.

They can also be a destination for investment through FDI if marketed efficiently

Program Management Agency (PMA):

Considering the complexities involved in implementation of the Scheme, the MFPI has proposed to engage a professional Program Management Agency (PMA) to assist the Ministry in the implementation of the scheme. The PMA will run as a professionally managed business organization without any political intervention.

6.7d Eligibility Criteria and Financial Assistance

The proposed Mega Food Parks scheme will be eligible to all categories of entrepreneurs and emphasis will be on the economies of scale and viability of the projects. Financial assistance will be made available up to 50% level (75% in certain areas) to ensure success of these ventures on market-driven bases.

The role of the Government in such activities needs to be to streamline the process, address safety and stimulate undertaking of such businesses by the private sector. The Government must not be involved in buying and selling any commodities, this is the role that private sector performs much efficiently as has been seen in almost all cases. The regulatory process must also be simplified and accountable. Only by setting transparent system of operation can these industries flourish which otherwise are very vulnerable as they handle seasonal and perishable produce which cannot be subjected to bureaucratic delays of any kind.

6.8 Total Economic Impact Calculations for Value-Addition

It is important to calculate an economic impact before any project is undertaken at the national level. The need for project identification and priority setting was stressed in the Swaminathan's report (2005) and TACSA suggests a mechanism to achieve that goal. The *IMPLAN* system (see below) may be used for the construction of regional input-output models for any district or state based on a combination of county-level and national economic data. This is particularly important for AEZs and Food parks that will be based on concentration of cultivation of specific crop in a particular location, hence the impact of this activity needs to be evaluated scientifically. This may be complemented by

CSIRO, Australia, prioritization model to scientifically determine which of the projects will have maximum economic impact on the society. For example, analysis of a single state (Florida) using this approach yielded the following data: The economic impact of the fruit and vegetable industries in Florida alone had direct employment of 48,000 persons, industry output of \$5.7 billion, and value addition of \$2.2B. Total economic impact includes \$11.5B in output; \$6.0B in value addition and 135,000 jobs with \$3.8B income to employees. Farm production of fresh fruits, vegetables, and tree nuts accounted for total impacts of over 88,000 jobs; \$6.6B in industry output; and \$3.5B in value added products. Such analyses are required by various area of agriculture by dedicated agriculture statistics institutes such as, IASRI, Delhi.

Total economic impacts of any value addition can be computed by using this computer-modeling program *IMPLAN*. For details see: www.implan.com. This program describes input-output equations accounting of commodity flows from producers to intermediate to final consumers, allowing scientific and objective quantitation of the complex issues free of any bias. Applying the economic multipliers as follows can provide analysis of any such data:

Summary of IMPLAN program and equations:

$$T_{\text{(Output, VA, Emp)}} = E \times M_{\text{T(Output, VA, Emp)}} + (\text{LFD} + \text{ID}) \times M_{\text{D(Output, VA, Emp)}}$$

where

$T_{\text{(Output, VA, Emp)}}$ = total economic impacts

E = export demand (sales)

LFD = local final demand (total final demand less exports)

ID = intermediate industry demand from non-agricultural sectors

$M_{\text{T(Output, VA, Emp)}}$ = total effects multiplier (direct + indirect + induced effects) for output, value-added, employment

$M_{\text{D(Output, VA, Emp)}}$ = direct effects multiplier for output, value-added, and employment.

The total final demand less exports represents local final demand. The base information on output and exports for each industry, as well as the multipliers, can be easily provided by the *IMPLAN* system free of any bias.

This program is applicable to any commodity for calculating local, state or national data in an objective manner.

Using this model the institutes like IASRI should calculate value of each commodity for further financial inputs by the Government rather than making decisions based on fragmented information. Such an exercise will yield

meaningful results and help in accountability for any investment in agriculture. This would be even more important for secondary agriculture initiatives as input/output equation must be clear for private investments to flow in this sector.

7

FOOD AND FEED GRAINS AND THEIR BYPRODUCTS

India is almost self sufficient in grain production and is the second largest rice producer in the world, with a 20 per cent share. It produces about 200 million tons of different food grains every year. The major food grains grown in India are wheat, rice, corn, sorghum and millet, and a variety of legumes (pulses). All grains contain varying degrees of protein, starch oil and minerals. These differences in grain composition can have a profound effect on how grain is utilized for processing to derive specific products from them. The grain processing industries in India are very primitive; most having old and inefficient equipment and very few byproducts from grain are made. Due to the lack of value addition most products are sold as commodities. This industry is most advanced in the West where hundreds of food and non-foot industrial products are made from wheat, soy and corn. During 2006-07, the Ministry of Food Processing sanctioned 32 rice mills, 13 flourmills, 62 edible oil mills and 13 pulse mills. All major grains, such as paddy, wheat, maize, barley, millets like jowar (great millet), bajra (pearl millet) and ragi (finger millet) are produced in the country. The following grain-based secondary agriculture industries offer potential for India as envisioned by TACSA, with specific input provided by Dr. Suri Sehgal, a veteran of the Global Seed Industry.

Grain processing industry normally operates as a high volume/ low margin business and therefore efficient processing systems to reduce per unit cost is extremely important. The processing industry needs a good supply chain, timely supply of the raw materials throughout the year to minimize down time, skilled work force, and an efficient delivery chain from the factory to the consumer, or the port in case of exports.

7.1 Soybean

Soybean Success in India: Soybean (*Glycine max*), known as a 'miracle crop' with over 40% protein and 20% oil was introduced in USA in the 18th century, and USA became the largest producer of soybean in the world (Hymowitz and Harlan, 1983). In India soybean has been traditionally grown on a small scale in Himachal Pradesh, Kumaon Hills of Uttar Pradesh (now Uttarakhand), Khasi Hills, Manipur, Naga Hills, and parts of central India including Madhya Pradesh. The bean is referred to locally as *bhat*, *bhatman*, *bhatmas*, *ramkulthi*, *garakalay*, and *kalitir*. Because of many health attributes such as high protein and oil content, and its beneficial effects on soil fertility, several attempts were made to popularize soybean cultivation in India. However, these initiatives were not very successful, mainly because of the inadequate knowledge about its cultivation, lack of high-yielding varieties, and unfamiliarity with its utilization.

To deal with the country's perennial protein malnutrition (which still exist, Gupta 2002), efforts were initiated in the mid-1960s by the G B Pant University of Agriculture and Technology, Pantnagar and the Jawaharlal Nehru Krishi Vishwa Vidyalyaya, Jabalpur (Madhya Pradesh), in collaboration with the University of Illinois, USA to popularize soybean cultivation in India. Soybean has now become an important crop in India from only about 11,000 ha in 1961, soybean occupied over 6 million ha in 2003 producing over 6 million ton making India the 5th largest producer of soybean in the world.

Soybean is the largest source of vegetable oil and protein in the world, and its large-scale

cultivation is concentrated in Argentina, Brazil, Canada, China, India, Paraguay, and USA, which together produce about 96% of the world's 189 million ton annual soybean production. The world's average soybean yield has also increased from less than 1 ton per ha to 2.3 ton per ha.

Developing improved soybean varieties: In 1970's, the USAID arranged the import to India of the world collection of soybean germplasm lines maintained by the United States Department of Agriculture (USDA). A total of about 3500 lines were sent to India through USAID. Of these, two lines – PI171443 [a cultivated soybean (*G. max*), originally from China] and *Glycine formosana* (a wild soybean, also from China) were found completely resistant to yellow mosaic virus. These resistant sources were used in a hybridization program, and a number of varieties were developed. Without the germplasm from USDA, the soybean-breeding program at Pantnagar would have not been successful.

The average yield of soybean in India is only about 1 ton per ha, compared with 2.3–2.8 ton per ha in other countries and much below the variety initially introduced from USA. Therefore, the greatest challenge for Indian scientists is to increase the average yield of soybean. This can double the production to 12 million ton from the same 6 million ha cultivated area – a net increase of US\$ 2 billion per year to the farm economy. Further diversification of soybean uses through the development of high-value and health-oriented food products as well as non-food industrial products as are being made in the West, may add significant value (over \$50 Billion) to this industry.

Development of a Market for Soybean in India: Unlike other pulses, soybean could not be used directly as dhal or flour because of its different taste and cooking properties, and it was too expensive to be used as animal feed. Industrial processing was the only immediate route to creating a market for soybean in India. Fortunately, more than 85 solvent-extraction plants existed in India in 1970, and most of them were running well below their capacity for the need of raw materials. This provided an opportunity to use soybean for oil extraction. A successful entrepreneur, managed to extract all the oil from soybean, and produced a food-grade good quality defatted cake with over 50% protein. To find a food use for the defatted cake resulting from the solvent plant at Aligarh, the food scientists at Pantnagar University adopted the textured soybean protein technology from

USA. This led to the establishment of an extruder cooking plant at Bareilly, which converted the defatted soybean cakes into textured soybean protein (TSP). Under the brand name Nutri Nugget, this product emerged as an ideal substitute for *paneer* (coagulated milk) and meat for the vast masses of vegetarians in India. The two products – soybean oil and Nutri Nugget – became popular (Rathod 1976). India thus was pioneer in making this byproduct from soybean, until its usefulness was discovered by the Western countries. Today, the US has overtaken this market and is producing hundreds of food and non-food products from soybean (see fig 4).

Scientists in India developed several other snack foods using soybean with maize (*Zea mays*) and rice. Several plants started operations in Madhya Pradesh, and soon soybean production fell short of demand. Today, there are numerous extraction plants and extruder cookers in India, and Nutri Nugget has become the common people's meat, being sold in every nook and corner of India. This product, however, could not compete in the international market as its quality could not be improved in time before others accomplished that goal.

The food scientists at Pantnagar collaborated with the scientists at the University of Illinois and developed a pilot plant to produce soybean milk without the beany flavor. The process yielded 10 L of milk from 1 kg dry soybeans – about five times as cheap as the production of bovine milk (Nelson *et al.*, 1976).

Soy based products are now the fastest growing food products in USA, being mixed even in meat, such as hamburgers. American Soybean Association is now marketing soy products even in India and has established several field offices to achieve this goal. India was pioneer in this technology 25 years ago but due to poor marketing could not capitalize the global markets which has since grown to be more than 100 fold higher and the Western companies as well as China has developed superior technologies in the mean time and are producing and distributing these products around the World. For a primarily non-vegetarian country, India needs to stimulate production and utilization of this high protein product at a large scale adding further value to soybean.

The domestic production of soya is not sufficient to cater to the edible oil requirement of the country. Hence, soybean export from India is not allowed. At the same time, bean imports are also not allowed so as to encourage domestic

production. Given the potential of this industry, it needs to be completely deregulated allowing it to flourish as it has done with in a short time in USA.

A close co-operation and collaboration between the National Research Centre for Soybean (NRCS) Indore, Madhya Pradesh and work going on at several Food Related institutes, needs to be coordinated with the soy processing industries to add value to this agro resource. This development needs to be supported by the private-sector investment in soybean utilization and marketing in India.

7.1a Food and Non-food products from Soybean

Soybeans grown in US are crushed (solvent extracted or screw pressed) primarily for meal and oil. The oil is refined for food or industrial uses. Meal is fed to animals or exported, with some used in industrial applications. In India, soybean is raised primarily for oil. With a limited animal-feed industry, almost 65% of India's soybean meal is exported as GMO-free meal. There is a huge opportunity for soy-based products for humans in India as it provides high protein and has various health benefits. Most of the soy protein for health food is in fact imported in India at a cost of 10 time that of what is exported as soy cake, which is the raw material to make this finished product. Technologies to do so exist in India (Dr. Ali, personal communication) and can be further developed at CFTRI, Mysore, in direct collaboration with industries.

The vegetarian Indian population meet mostly, their dietary protein requirement from pulses, cereals, oilseeds, milk, etc. Population below poverty line (BPL) do not have enough purchasing power even to buy pulses. The alternative source of very good quality dietary protein, which is affordable, is soybean with 40% protein and 20% oil and also provides 23% carbohydrates and minerals and vitamins (Table 1). It is the most economical protein source in the world.

A Soybean Processing and Utilization Centre (SPU) was established at the Central Institute of Agricultural Engineering, Bhopal in 1985. Dr. Kulkarni, Project Director, provided the following information:

R & D efforts at SPU were made to develop few process technology and equipment (Table 1) for soy food products suiting to Indian tastes and preferences. Limited commercialization of the

technologies was done through training and entrepreneurship development. Consequently, the image and the acceptance of soy as food have been significantly improved these days. Promotion of soy foods in India is a need for better health for population. Approach to popularize soy foods can be:

- i) Transform the soy-foods into local taste by incorporating soy ingredients in most of the traditional food formulations.
- ii) Allow consumers to acquire a taste for soy products. Feed children with soy products since their preferences are easily shifted.
- iii) Domestic scale soybean processing for food uses be encouraged.

Soy foods are rich and unique dietary source of isoflavones, phytoestrogens, which lowers serum cholesterol, levels. The health professionals have gradually begun to appreciate the hypocholesterolemic effect of soy protein. The official recognition in 1999, with an authorization by the US Food and Drug Administration (FDA) to grant a health claim for soy protein made a significant difference about the acceptability of soy in most foods.

Large soy oil processing industry and SPU trainees turned entrepreneurs (Table 3) in different states make different soy products (Table 4) available to consumers. Variety of soy products are manufactured by large, small and cottage scale enterprises spread in different states all over the country.

Full fat soy flour (FFSF): One of the simplest products is in the form of full fat soy flour (40% protein, 20% oil) for use in combination with cereals and pulses. Use of soy-cereal/pulse blended flour (10-20%) in recipes does not demand any change in food habits of the consumer.

Table 7. Present Indian soybean processing industry

•Oil extraction plants	154
•Food manufacturing units	125
•Equipment manufacturers	30
•Trading houses	15
•Government & other agencies	06
•Cottage scale soy food units	190
Total	518

Soya milk: One kg of dry soybean yields 6-8 litres of soymilk nutritionally comparable with cow milk. It can be used for feeding infants, as supplement to diets of pre school children and substitute in diets of patients who have allergy to milk protein. It is base material for preparation of soy based dairy analogs like *soy-paneer*, *soy-ice cream*, *soy shrikhanda*, *soy-amrakhand*, *soy-curd*, *soy-mattha*, *soy-lassi*, *soy-rasogulla*, etc.. Okara by-product of soymilk unit can be used for preparation of *Gulab Jamun*, *halwa*, *pakoda*, biscuits etc. Homemade soymilk is considered healthier because it is fresh and does not contain additives and preservatives like commercial soymilk (Kanthamani et al., 1978). If made in the morning the soymilk will be safe to use all day without refrigeration. If properly cooled after boiling it can be kept for about 10 days under refrigeration.

Soy-fortified Biscuit and Cake: Bakery products are recognized as most efficacious means of delivering supplementary nutrition to children suffering from malnutrition. The soy-biscuits contain about 12% protein (50% more than the equivalent biscuit in the market), 24% fat and 500 kcal per 100 g. Consumption of four biscuits a day meets about 12 % protein requirement of a 6-9 year old child and gives 100 kcal.

7.1b Training and Entrepreneurship Development

As a result of training at SPU started in 1995 for making available soy-products to the population, so far, more than 170 cottage scale enterprises have been established in different states and a variety of soy products like soy milk, soy paneer, fullfat soyflour, soy nuts, soy fortified biscuits are made available. The six-day training of entrepreneurs is a regular activity (every month) at SPU. A close co-operation between CFTRI and SPU is required to pool their technical resources and build other soybased products shown in Table 8.

Isoflavones from soygerm: Soy germ/hypocotyl is the source of the "beany flavor" and undesirable taste in soy products. But Isoflavones present in soy axis are shown to possess antioxidant, antifungal activity. Recently, ways of preparing products with soybean hypocotyls retaining isoflavones and having good flavor and roasted soybean hypocotyls and beverage material containing isoflavones has been reported. Total isoflavone content of American and Japanese soybeans in the tested soybean varieties ranging from 1.26-3.88 mg/g seed. Soy germ constitutes

Table 8. Some of the soy products, processing equipment and technology developed at SPU, CIAE, Bhopal for food uses of soybean

Soyproducts and Technology (24)	
Soydal - instant	Soymilk
Soyflakes	Soy <i>paneer</i> (tofu)
Soyflour	Soy-yogurt
Soyfortified biscuits (sweet)	Soy-ice cream
Soyfortified biscuits (salty)	Tempeh
Soyfortified bread	Soy-sattu
Soyfortified muffins/cup cake	Okara based <i>burfi</i> & <i>Gulabjamun</i>
Soyfortified bun	Soy-sauce
Soy-snacks (roasted/fried)	Soy- <i>srikhand</i>
Soy- <i>amrakhand</i>	Soy -Semolina (<i>suji</i>)
Soy based <i>Rasogulla</i>	Soybased sweet analog.
Soybean Processing Equipment (21)	
Cleaner -Grader	Plate type wet grinder
Manual dehuller	Modified oil expeller
Power operated dehuller	Low-cost steam generator
Blancher	Soybean cake grinder
Natural convection tray dryer	Dough mixer-(Lab. unit)
Forced convection tray dryer	Lever-type paneer pressing device
Multipurpose LSU type dryer	Screw-type paneer pressing device
Three-roller flaking machine	Cottage level soypaneer plant
Two-stage roller mill for soyflake	Low-cost single screw forming extruder
Thermic fluid based deep fat frier	Biscuit cutter -(Lab. unit)

Integral Extrusion-Expelling Unit -(Lab. unit)	
Pilot Plant Production Facilities for (6)	
Fullfat soyflour	Soypaneer
Partially defatted soyflour	Soyfortified bakery products
Soymilk	Soy ice-cream

about 2% of soybeans and contains 5-6 times higher amount of isoflavones than that in cotyledons. Soy Axis has 10% fat, having higher proportion of unsaturated fatty acids (linoleic and linolenic) and lowest relative percentage of oleic and stearic acids. Presently, hypocotyls are disposed off along with hull without separating from the cotyledons, which may be used as feed material. CFTRI has an Indian patent on the separation of germs or hypocotyledons from soybeans. Hence isoflavone rich fraction can be prepared starting from soy germ. This process can be developed in collaboration with a soy processing industry.

ADM (USA) operates the world's largest soya isoflavone concentrate facility. ADM produces isoflavones in concentrations from 20% to 70%, in products specially compounded to facilitate handling and tableting. Isoflavones are major food supplement for better health. The global market for isoflavones is over \$200 Million/year.

Presently, 10-40% isoflavone extract concentrations of soy are available in the market. Hence soy germ makes a very good starting material for the preparation of isoflavone rich extract. World soy production (2006-2007) is 235 million tons. Hence there is a potential of 4.7 million tons of soy germ production, containing 37 tons to 111 tons of isoflavones, (based on 7.8-23.4 mg/g isoflavone content in germ fraction). Soybean production in India is about 7 million tons (2006-2007) contributing Rs 5000 crores to Agro economy (CRN India). Of the total production of soybean in India, 10-12 % is directly consumption and the rest is crushed for soy meal and oil. Hence the potential to produce soy germ is significant, if integrated with the soy processing industries. CFTRI needs to take a lead in this area to work with such Industries to add further value to soybean agriculture commodity.

Soy pulp or Okra: Okra is a byproduct in the soymilk production industry. It is the residue that is left over after the milk is filtered through. This contains significant amount of proteins (~30%), fat (~10%), crude fiber (8-10%) and carbohydrate (~40%). Okra can be a source of good quality protein with dietary fiber. It can be

used to prepare many nutritive foods. There are methods for increasing the shelf life of Okra, which otherwise has a short life because of high moisture. Okra can be dried and used to prepare soy flours, free from oligosaccharides, lipoxigenase and to some extent trypsin inhibitors, as it has gone through water washing and also heat treatment. This flour can be incorporated into various foods for its high protein content and quality.

Soya meal: This is a byproduct of soybean oil refining unit. Most of this product is being exported from India at a very low price while high value products made from this material are being imported. Indian soya meal is slightly cheaper when compared with the American or Brazilian soya meal, which costs about US\$275-300 per metric ton. The Indian soya meal costs around US\$260-270 per ton. Only India supplies non-GM soya meal while the U.S., Argentina and Brazil manufactures mainly GM soya meal, giving India an advantage as Non-GM supplier.

Raffinose and Stachyose: The two principal soy oligosaccharides are the raffinose and stachyose. They are marketed in Japan as dietary supplements and added to functional foods. These prebiotics may have anticarcinogenic, antimicrobial, hypolipidemic and glucose-modulatory activities. They may also have activity in improving mineral absorption and may have anti-osteoporotic activity. Oligosaccharides constitute about 5% of soybean. These can be recovered from the water washings of the beans before the preparation of soymilk, and using membrane technology, concentrates of the same can be prepared.

Saponins: Soybean is the major source of saponins in the human diet. Since soy products are the important resource of protein in many Asian countries, consumption of saponins in the diet reduces the risk of cancer. Saponins are present as a minor constituent (0.5-5.0%) depending upon varieties of soybean. Saponins render a bitter taste to soy products and it is also considered as anti-nutritional factor. During processing of soybean protein concentrates most of the saponins are removed through

ethanol extraction. However, in recent years, saponins are recognised to have beneficial biological effects in the diet as functional ingredients in lowering blood cholesterol, preventing cancer and immune stimulatory properties.

Saponins possess anticarcinogenic property through several mechanisms having amphiphilic nature. Saponins possess hypocholesterolemic property and immune stimulatory property. Soybean saponins reduce the diet induced hypercholesterolemia, increasing bile acid excretion and also forms complexes with bile acids *In vitro* to reduce absorption. Tofu, produced from milk coagulation, shares saponins with whey during preparation of tofu.

Soy Lecithin: Lecithin is one of the most important byproducts of soybean oil refining industry. Lecithin is obtained during degumming of the soybean oil and constitutes about 1.5-2.5 % of the oil. Lecithin has various uses including almost all the food industries, paint, varnish and cosmetic industry. Though lecithin from other edible oils can also be obtained, soy lecithin is the one widely used. Soy oil production in India is about 1 million tons, indicating a potential of 15000 tons of soy lecithin production.

The price of lecithin in the international spot market has remained stable at US\$0.25-0.28/lb or unbleached lecithin and US\$0.31-0.35/lb for bleached lecithin. The global market for soy lecithin products is approximately 150,000 tonnes/annum, of this up to 120,000 t/annum is a standard grade lecithin.

Lecithin has a wide range of food and industrial applications. The major uses are: Animal Feeds, Instant Foods, Margarine, Confectionery, Pharmaceuticals, Baking Products, Sliced Cheese, Chocolate, Cosmetics/Shampoo, Release Agents, Milk Powder, Dehydrated Foods, Paints, Plastics, Magnetic Tapes, Ice Cream, Health Foods, Cereals. The margarine industry is the largest user of lecithin with approximately 480 tons consumed each year. The growth in the health food market, estimated at approximately 10% p.a. where large proportion of de-oiled and purified lecithin is consumed.

Other soy products: Few other soy-based products have been developed in India at the Central Institute of Agricultural Engineering (CIAE), Bhopal. These include protein-rich and multi-purpose full-fat soy-flour, soy-paneer (also known as tofu) and soy-fortified biscuits. Full-fat

soy flour is one of the simplest soy-based food products. It can be blended with wheat flour and that of 'gram' and pulses. To demonstrate the technology, the pilot plants for processing have been established by CIAE. This technology needs to be fully exploited at an industrial level to build various soy flour-based products

India, despite being the world's largest producer of a variety of pulses (13-14 million tons) and fifth largest producer of soybeans (7-8 million tons), has not made enough efforts to value addition in pulses or soybeans. In the US, corn (Fig. 4) and soybeans (Fig. 5) are processed into hundreds of products creating several Billions \$ industries.

7.2 Other Grain Products and Byproducts

Wheat: World wheat production in 2006 was 653 MT, out of which 518 MT was utilized for human consumption and about 74.3 MT was taken as animal feed. Wheat is a major staple food in India, crucial to India's food economy and security. During 2006, production of wheat in India was 75.8 MT making India the second largest in the world. There are about 30,000 varieties of wheat; the most commonly used are *Triticum aestivum* (bread wheat) and *Triticum Durum* (durum wheat). Bread wheat is classified into several types based on the hardness of kernels.

India is the second largest producer of wheat in the world. Rapid economic growth and urbanization is leading to dramatic changes in dietary patterns across the country. Despite production reaching 70 to 75 million tons, the increasing demand has necessitated imports of wheat in recent years. Out of the total wheat produced, 10-15 Million tons is procured by the Government agencies. The roller flour milling industries in India, which are about 900 in number depend on the private procurement. The yield of products and by-products obtained vary from mill to mill. On an average, milling industry in India separates out 50-55% maida (refined wheat flour), 7-12% semolina, 8-10% resultant atta (simulating whole wheat flour) and 20-25% bran along with germ. In roller flourmill, there are three sets of rolls each consisting of two rollers and associated sifters. The first set of rollers has corrugated surface, one moving faster than the other causing the brown skin (bran) of the wheat grain to be sheared away. The output is then sifted. After the bran has been removed, the output is passed through two more sets of rollers and sifters to separate germ and finally producing floors. In India, the corrugated surface

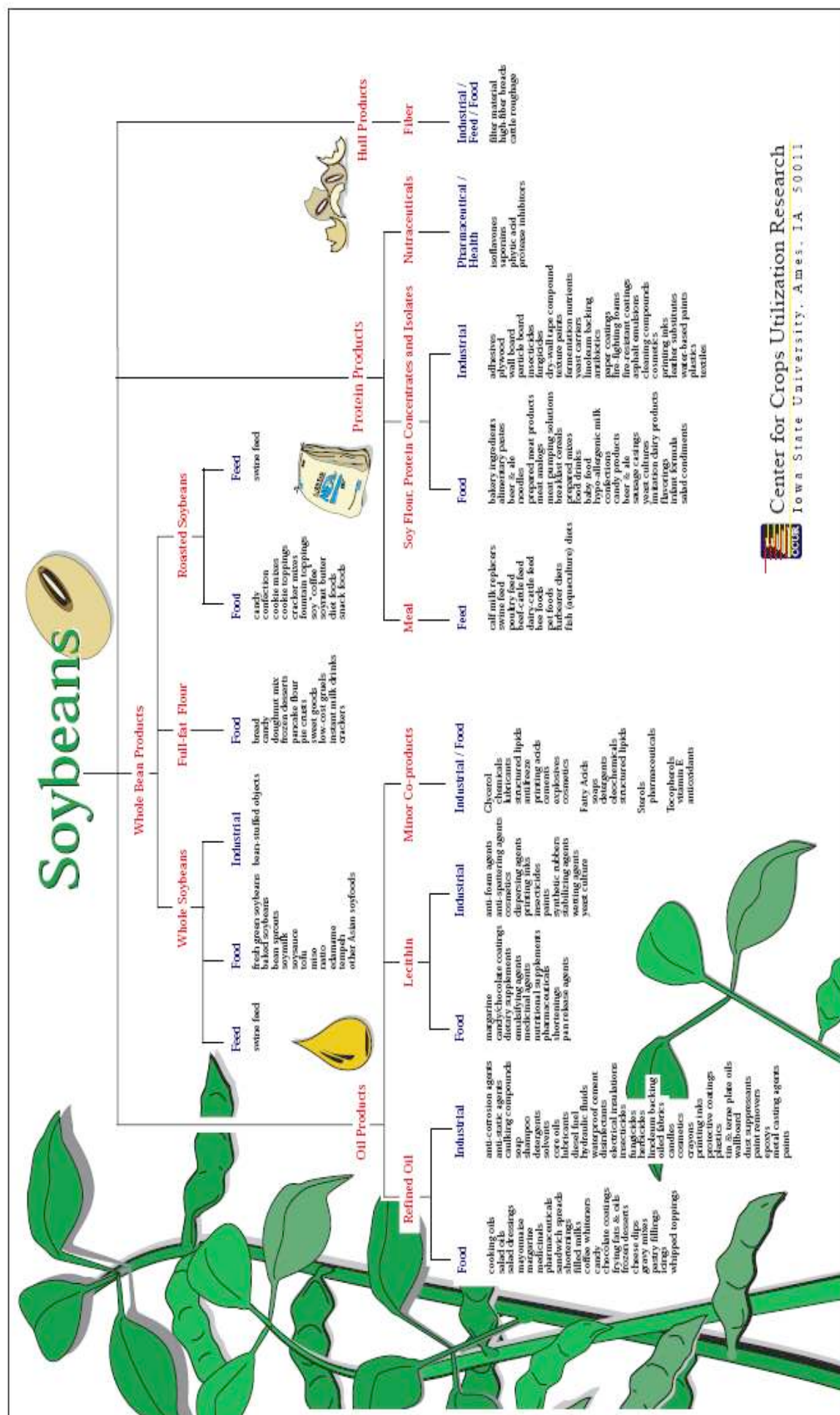


Figure 5: Examples of Secondary Agriculture products from Soybean

of the first set of rollers is designed to actually crack the wheat grain and not to just shear it resulting in the production of *atta*. Whole meal flour represents an extraction of 94% to 98% of the wheat grain. Minimum amount (2% - 6%) is sifted away as bran. 75% of the wheat grain as extracted are refined wheat flour. Most of the bran and germ are sifted away leaving mostly the endosperm. Milling of wheat into flour aims at the maximum extraction of the endosperm with minimum possible contamination of bran and the germ, which form the by-products of flour milling industry. Further, depending on the extraction rate during milling varying proportion of germ finds their way into various flour, which adversely affects the storage stability as well as the baking quality of flour. The flour produced by the industry is mainly consumed by the baking industry. The other products viz., *sooji* and *atta* are utilised for the preparation of traditional products. Wheat germ, bran, shorts and middlings are the by-products of milling industry. Some of these are used for human consumption and others as livestock feed. Some are used for industrial products.

Wheats grown in India are of three types: hard, medium-hard and soft, based on their protein content and suitability for different purposes. Protein quality has a large effect on how different types of wheat are utilized. Lower protein soft wheats are used for making cakes, cookies, and biscuits. Medium-hard wheats are used for making unleavened breads and noodles. Hard wheats with high protein content are appropriate for making breads. Wheats with similar protein content can have dramatically different bread-making properties. Extra-hard durum wheats are used for making pasta products. There are over 100 types of pasta produced around the world offering great potential for Indian industries to develop this sector for national consumption as well as for export.

Almost 83% of the kernel weight and the source of white flour is endosperm. The endosperm contains the greatest share of protein, carbohydrates and iron, as well as the major B-vitamins such as riboflavin, niacin, thiamin and iron. It is also a source of soluble fiber. Most Indian wheats are soft or medium-hard. These are used for making *chapattis*, *nans*, *pratha* and *roti*. In India, more than 50 million tons of wheat is processed every year into whole wheat-flour (*atta*) at the *chakkies* or disc mills that are small enterprises spread all over the country. There is a vast potential for setting up small flourmills that can formulate flour for different usage. This untapped market is likely to create significant

number of rural jobs and prevent grain waste in each household, a major loss of this vital agriculture commodity. This will improve quality (nutritional value) and deliver in time needed *atta* to the rural and urban population. Further value addition to the wheat flour can be done for readymade mixes such as for baking use.

In India, the milling industry is producing wheat flour (*maida*), semolina (*suji*), *atta* and bran. There are about 820 roller flourmills in India with a total capacity of more than 15 million tons. The actual grinding in the country is about 8 million tons with a capacity utilization of only 50%. This is partly due to the lack of power and the supply of grain, making this industry inefficient and increasing the cost of the end product. Not only this industry needs to be fully utilizing its capacity but making ready made mixes for various products and branding those products would add significant value to this commodity.

About 14% of the wheat kernel weight is bran. The bran is included in whole-wheat flour and is also available separately. Bran is the hard outer layer of grain and consists of combined aleurone and pericarp tissue. Along with germ, it is an integral part of whole grain. It is often produced as a byproduct of milling. When bran is removed from grain, it loses a portion of its nutritional value. Bran is particularly rich in dietary fiber, and contains significant quantities of starch, protein, three major B vitamins, and dietary minerals. It is a good source of folic acid. Bran contains a number of antioxidants that include vitamin C and E, and trace elements such as manganese, zinc and copper. In fact most flour products are poor in zinc because the bran is removed during processing. Zinc deficiency may cause serious health problems.

Only 2.5 % of the wheat kernel weight is germ. The germ is the embryo or sprouting section of the seed, often separated from flour in milling because of its fat content (10 percent) that limits shelf life. The germ contains minimal quantities of high quality protein and a greater share of B-complex vitamins and trace minerals, and is a good source of vitamin E. Wheat germ can be processed and sold separately both as a breakfast cereal additive as well as for making Vitamin-E (see below).

Wheat germ oil is extracted from the germ of the wheat kernel. Wheat germ oil is very high in vitamin E. It is used as an emollient and alleviates dry, itchy skin. It is rich in lecithin and vitamins A, D, and E. The antioxidant activity of vitamin E, which neutralizes the cell-damaging effects of free radicals, is associated with anti-

aging properties and is extensively used in cosmetics. It is claimed that wheat germ oil stimulates tissue regeneration and suitable for wrinkles, scars and stretch marks. Wheat germ is a good source of tocopherols (tocopherols and tocotrienols). Tocopherols have antioxidant functions. The global market of these products is very significant and is likely to grow as the cosmeceuticals industry in India and China grows. India needs to develop industries to cater to this growing market.

The industrial uses of wheat are based mainly on the properties of wheat starch and gluten. Gluten proteins, composed of gliadins and glutenins, are responsible for the formation of the viscoelastic complexes of dough that trap carbon dioxide produced by yeasts, thereby forming the spongy and chewy texture of bread. Most wheat grain proteins reside in the endosperm. Proteins in other cereals do not behave like gluten.

The wheat starch is composed of two types of glucose polymers, amylose (24%) and amylopectin (76%). In waxy wheat, starch is composed entirely of amylopectin. The major industrial uses of wheat starch are in the paper industry as it makes paper stronger, in the production of many types of adhesives, and for producing syrups and sugars. Gluten is used to fortify flour and add rigidity and volume to specialty baked goods. Wheat gluten is unique due to its ability to be elastic, bind water and form films that can be stabilized with heat. These properties render wheat gluten useful for the preparation of adhesives, coatings, polymers and resins. Even the spoiled and old wheat grain can be used for this purpose. It is estimated that only 2 % to 4% of the total wheat in the world is used for industrial applications but the value of the end products is significant.

Wheat germ: The embryo or sprouting portion of wheat, which constitutes 2.5-3.0% of grain, can be obtained in a fairly pure form either by using a germ separator or by suitable adjustments in milling techniques. Wheat germ, the heart of the wheat kernel, is richly packed with protein, fiber, polyunsaturated fat, vitamins, and minerals. It is the most nutritionally dense part of the wheat kernel, which also includes the endosperm and bran, or outer husk. Wheat germ, a nutritious by-product of flour milling industry contains highly concentrated nutrients: 3 times as much protein, 7 times as much fat, 15 times as much sugars and 6 times as much minerals when compared to wheat flour. The raw germ contains 31.4% protein, 18.4% dietary fiber and 7% fat. The carbohydrate content in

germ varies between 19-53% depending on the contamination with the endosperm and bran portions. It also contains 64% of the vitamin B₁, 26% of the vitamin B₂, 21% of the vitamin B₆, and most of the fat of the wheat grain. Its high vitamin and mineral contents make it an extremely nutritious food. Nutritionally concentrated germ and high palatability makes it ideally suitable for enrichment of processed foods like bakery and traditional products. However, wheat germ has poor shelf life due to the presence of unsaturated fatty acids, oxidative and hydrolytic enzymes, rendering the product highly susceptible to rancidity. Wheat germ is used extensively in animal feeds, but for human consumption, wheat germ meal and wheat germ oil are the two most popular preparations of the grain. Wheat germ can also be explored as potential resource for purifying some of the oxidative enzymes viz. lipoxygenase for end use in bakery products

Wheat bran: Bran is the hard outer layer of the grain and consists of combined aleurone layer and pericarp. Along with germ, it is an integral part of whole grains, and is often produced as a by-product of milling in the production of refined grains. When bran is removed from grains, they lose a portion of their nutritional value. Bran is particularly rich in dietary fiber, and contains significant quantities of starch, protein, fat, vitamins, and dietary minerals. Wheat bran on the other hand contains 5.7% ash, 14.7% protein, 11.2% carbohydrates and 46% of total dietary fiber. Wheat bran is also an important source of vitamin E. But during processing of wheat for human consumption, a marked reduction in vitamin E content occurs. Currently wheat bran is utilized as animal feed. Among the different milling fractions, the bran has the highest phenolic content, while the endosperm possessed the lowest. Bran is often used to enrich breads (notably muffins) and breakfast cereals, especially for the benefit of those wishing to increase their intake of dietary fiber. Thus, these attributes enable to utilize the wheat bran in developing newer value added products.

7.2a Wheat Byproducts

Vitamins and tocopherols: Vitamin E has been associated with better heart and circulatory health, anti-inflammatory properties, and the reduction of body-ageing free radicals. ADM is the largest producer of natural-source vitamin E. ADM has developed powder formulations specifically designed for better flow and compressibility. ADM is also the leading provider of mixed tocopherols, as well as high-gamma tocopherol.

Lecithin: Used extensively as an emulsifying agent in a wide range of foods, it is also a good source of phospholipid choline, which may help maintain and support liver health and cognitive brain function. ADM produces both a liquid form and a de-oiled powdered form for capsule manufacture.

Phytosterols: Phytosterol and phytosterol esters are a class of plant-derived compounds that have proven effective in blocking the absorption of cholesterol. ADM produces these compounds from grains.

Enzymes: A number of enzymes, used industrially can be found in the cereal grains. Lipase, for example, is found in wheat germ, bran as well as in oat hulls (Rajeshwara and Prakash 1994). It is used to hydrolyze fats and oils without damaging other constituents including vitamins or unsaturated fatty acids. Lipase is used in the food industry for flavor enhancement and in detergents for the improvement of cleaning action, such as in leather industry. Carboxypeptidase and phytase are also present in wheat bran. Phytase is used to hydrolyze phytic acid to improve animal feed quality.

Acid phosphatase, sucrose synthetase and sucrose phosphate synthetase are found in wheat germ. Lectins, acid phosphatase, β -amylase inhibitor is extracted from wheat and barley. Amylase inhibitor's have potential for use in the treatment of wheat kernels to prevent sprouting during harvest.

Phytate and Phytate Derivatives: Phytic acid is found in the cereal grains including wheat and corn. It is used as a complexing agent for heavy metal ions and as a sodium salt. Phytin is a phytic acid calcium magnesium salt, which is found in a number of grains. One of the primary sources for phytin is corn steep liquor. Phytin is used as a nutrient, tonic, calcium supplement and as a feedstock for inositol manufacture.

Wheat germ oil: Wheat germ oil and unsaponifiables are produced under several different trade names and used in a number of different cosmetic products. Wheat lipid oxide is marketed under the trade name Mackernium WLE.

Quaternary Ammonia Compounds: A variety of quaternary ammonium compounds can be produced from wheat. These include: wheat abetaine, germamidopropyl dimethylamine, germamidopropyl dimethylamine, hydrolysed

collagen, germamidopropyl dimethylamine hydrolysed wheat protein, germamidopropyl dimethylamine lactate, wheat germamidopropyl dimonium hydroxypropyl hydrolysed wheat protein, germamidopropyl silk hydroxypropyl dimonium chloride and germamidopropyl ethyldimonium ethosulfate fall into the category of quaternary ammonium compounds. Quaternary ammonium compounds are used as preservatives, surfactants and antiseptics and are generally derived synthetically from ammonium chloride. They are used for deodorants, after-shave lotions, shampoos, antiperspirants, cuticle softeners, hair products, hand creams and mouthwashes.

The following wheat grain-based secondary agriculture industries offer potential in India:

- Wheat germ can be exploited as sources of vitamins E and B-complex.
- Wheat germ is a good source of healthy vegetable oil. It can be extracted to supplement other sources of vegetable oil in the country.
- Wheat germ can be used as high value animal feed.
- Industry can diversify into specialty flours, such as, high gluten flour, hard whole wheat flour, soft whole wheat flour, organic soft wheat flour, mixed flour, etc, to meet specific needs of the bakery industry.
- Breakfast cereals, snacks, chips, etc. are other opportunities that need to be exploited.
- Pure wheat gluten is used in a variety of products.
- Wheat straw is a key source of animal fodder in North India. In addition, many possible composite products can be made using wheat straw alone or by combining it with other resources.

7.2b Rice and rice Products

Rice is the most important food grain in India. It is the staple food for 65% of the total population. India is the largest exporter of *basmati* rice primarily to Europe, Saudi Arabia and the Gulf countries. Recent shortage of rice has temporarily brought a halt to this export.

In 2005/06, the acreage under rice cultivation was 43.66 million ha with the production of 92 million tons. Average yield of rice per ha seems to have reached to a plateau, as is the case with wheat. This productivity is low in comparison to other Asian countries and seems to be limited by

agri-inputs and the soil micronutrients health (Gupta and Gupta 2007). The ICAR institutes need to make special efforts to ensure that farmer has the knowledge and tools available to increase primary productivity of this important grain which supports a majority of Indian food habits. Simple change in farming practices, as developed at the Cornell University, USA, can increase rice crop productivity by 10-20%.

In Punjab, Haryana, and parts of Rajasthan, rice is grown under mostly irrigated conditions to supplement monsoon rainfall. At the end of harvest, fields of rice stubble are either plowed under or burned off. Burning of rice straw must be stopped as it not only pollutes the environment, but also damage the land and clearly there are better alternatives to get more value from the rice straw, such as making fiber (See Appendix). A field experiment conducted at IARI during the rabi season 2002–2003 to evaluate the efficacy of the various modes of rice straw recycling and soil fertility and reducing not only carbon dioxide emission but also nitrous oxide (N₂O) emission. The lowest yield was recorded where rice straw was incorporated in soil without additional inorganic N and with manure application (Pathak et al., 2006).

Rice straw has many other uses. In Thailand, approximately 10% of the straw is utilized as a medium to grow mushrooms, 50% for animal feeds, 30% in paper making, and the rest is burnt as fuel. Rice straw can be twisted into rope, made into sandals, mats, rugs, blankets, brooms, raincoats and even boots. None of these products are currently made in India using this natural resource. Rice straw has the potential to be used for making fiberboard (see Appendix XX), and better animal feed after removing most of silica.

- Central and State Governments. should issue policy documents to ban burning of rice and wheat straw as soon as possible.
- Alternate uses of rice straw needs to be demonstrated to farmers and the value generation concept has to be communicated at the farm level via extension people and demonstrations.

Rice grain basically consists of a husk (hull) and the brown rice. Brown rice consists of a bran layer (including pericarp, seed coat, and aleurone layer), a germ and scutellum, and an edible portion or endosperm. Rice milling removes the husk and the bran layer to produce the edible portion for consumption. The process

embraces two basic operations. One operation is the removal of the husk to produce brown rice: this is called dehusking (or dehulling). The other operation is the removal of bran layer from brown rice to produce polished or white rice; this operation is called polishing or whitening. Milling also removes the germ and a portion of the endosperm as broken kernels and collect it as powdery material.

Rice contains carbohydrates, vitamin B and proteins. Starch, both amylase and amylopectin, is a major determining factor of cooked rice, such as stickiness and firmness. Several alcoholic beverages are made from rice (broken rice). Examples include sake (rice wine), and beer. Common use of rice hulls are a bedding materials, and as a source of energy for grain dryers. In the modern rice milling industry, rice hull is used as a fuel source for grain drying, and parboiling for electricity generation.

In Thailand rice flour made from 30% broken rice, is used to produce rice pasta, chips, and other snacks, as well as rice cereals. More than four dozen value-added products are produced from derivatives of rice paddy in Japan. Approximately 70% of the broken rice produced in Thailand is used as feeding ingredients or made into instant noodles and snacks.

Rice bran is the most nutritious part of rice and provides a good natural source of vitamin B and E. Rice bran also contains small amounts of antioxidants and 10 to 23% bran oil. The oily nature makes bran an excellent binder for animal feeds. It is an excellent ingredient for animal feeds, in particular ruminants and poultry. Bran oil, once stabilized and extracted, is a high quality vegetable oil. It can be used in waxes and cosmetics. Two types of bran oils are produced, one crude and another purified. Some TACSA members visited a Bran oil mill in UP, the quality of the oil was found to be very poor and could be used only for industrial purpose. Much needs to be done to improve this industry as it directly affect the rice growers in terms of value capture and generates jobs in making high quality vegetable oil for human consumption. The country has potential of producing 13 Lac Tons of Rice Bran Oil while only making 7.5 lakh tons and only using 2 lakh tons for cooking. Among the players in this area are: Ruchi Oil, Sethia Oil Mills, Food fats and Fertilizers, and Maheshwari Solvents.

The following secondary agriculture industries can be developed based on rice crop:

- Extraction of rice bran-oil to supplement other vegetable oils in the country.
- Ingredients from rice bran used as animal feeds.
- Making of rice pasta, chips and snacks from broken rice.
- Ready to eat foods like puffed rice snacks and rice based breakfast cereals.
- Rice wine, rice beer.
- Rice husks can be compressed into briquettes for fuel and power generation (Lonia 2005). If carbonized, these briquettes become a high-quality charcoal.
- Rice straw can be used as a material for the production of paper and fiberboard construction products.
- Rice straw can be burned in high efficiency furnaces to generate electricity, and the ash produced is a good source of potash as a fertilizer.
- The rice straw can be used for organic fertilizer production and plyboards production.

7.2c Corn (Maize) and Corn byproducts

Maize is an important grain crop in India. In 2005/06, it occupied an area of about 7.6 million hectares with a production of about 15 million tons. Because of higher prices lately, the acreage in corn is on the increase.

The major states where corn is grown are Himachal Pradesh, Bihar, Rajasthan, Madhya Pradesh, Andhra Pradesh, Karnataka, Maharashtra, Gujarat and some parts of UP (for more data, see www.secondaryagriculture.org). India ranks fifth in area and tenth in production among major corn producing countries. However, the average corn yield in rain fed areas in the country is among one of the lowest in the world. In the states of Karnataka, Andhra Pradesh and Maharashtra, the crop is irrigated and planted with hybrid seeds giving better yield. Major gains in productivity in corn have occurred in these states. Similarly in Bihar the average yield is high and comparable to some of the sub-temperate countries because of the availability of irrigation, use of hybrid seeds and sub-tropical/conditions in the winter (Rabi) season especially under moderate night temperatures. Current average yield of corn in USA is ~8600kg/ha (Patzek, 2006) which is the highest in the World.

Corn grain can be processed into ingredients of food, feed, and many industrial uses. Major use for corn in India is for food (55%), and animal feed (livestock, 14%; poultry feed 18%). About 12 % of corn is used for starch extraction, the production of which is very limited in India as starch is not permitted in many processed food as is the case in the rest of the World. The scientific reason for this is not clear.

The normal corn kernel is comprised of pericarp; tip cap, germ, horny endosperm, and floury endosperm. The products from corn range from starch, protein, corn oil, sugars and syrup. Starch is composed of two types of polymers, amylose and amylopectin. Starch is synthesized in amyloplasts forming granules that differ in size and shape depending upon the cereal.

Cornstarch is an important industrial manufactured product. The industrial and food applications of cornstarch are many and significant in the food industry. Cornstarch is the main commercial starch in the US. Cornstarch can be converted in to ethanol, biodegradable plastic, compact disc, additives for pharmaceutical industry, paper, cosmetics and food industry. Corn oil is also a good source for bio-diesel production. Waxy starch lacks amylose. The starch of waxy corn is exclusively amylopectin.

Starch is the key product, which can be turned into many types of food. It also has many industrial uses. The starch can be converted into dextrose and corn syrup, both of which have multiple consumer and industrial uses. Dextrose is a pure crystalline sugar that is created in a reaction between cornstarch and an enzyme. In addition to its food uses, dextrose has many pharmaceutical and industrial uses as well. Dextrose is often referred as corn sugar. It is less sweet than sucrose. Like dextrose, corn syrups are created by processing cornstarch with acids or enzymes. Corn syrup is used to make many industrial and medical products, in either its liquid or dry form.

Corn is processed either by dry milling, or wet milling. Milling processes separate corn kernels into three basic parts, endosperm, germ, and bran. In dry milling, the endosperm is the primary product, which is further converted to food, and the industrial products. The pericarp and germ are separated and the corn oil recovered. The germ residue and pericarp becomes an animal feed ingredient. About 30 to 40 thousand tons of corn is dry milled in India by large-scale dry milling methods. Here germ is recovered by using specially degerming equipment. About 4

to 5 million tons is ground into flour in rural areas. No germ is recovered in this process. In India, mostly dry milling process is used to make feed. Gujrat Ambuja Exports have set up two major corn processing plants one in at

Himmatnagar in Gujrat and one in Uttrakhand. The Gujrat plant processes 500 tons corn per day.



Figure 6 : Examples of Corn-based Food and Non-food Secondary Agriculture Products

CFTRI has developed three types of dry maize milling mills. These are: Mini Grain Mill with a capacity of about 60kg/hr, Maize Mill with a capacity of 400 kg/hr, and IQ-D type Dry Milling Plant with a capacity of one ton/hr. The last one has all the features like cleaning, destining, water conditioning and degerming that exist in a large capacity modern dry milling system. The products and by-products obtained include bran, meal, germ, large grits, medium grits and small grits. The grits can be further ground to semolina and flour, and germ is taken for oil extraction.

In the wet milling process, which is not much used in India, the specific components of each kernel part (starch, protein, oil, fiber, and soluble) are separated into relatively pure fractions that have a wide scope of specific uses. Only 5% of the corn is wet-milled in the country but there is a big potential to increase it further. If developed, this milling process can generate a variety of secondary products and help create new jobs.

Alcohol (ethanol) is fermented from hydrolyzed purified starch obtained by wet milling, although this process is not recommended for India. Alcohol is also made by cooking and fermenting whole ground corn. The residue remaining after removal of the alcohol is an excellent feed material. Recently, most of the ethanol fermentation is done via dry milling process and the residue (distiller's grain) that is left after fermentation is a good material for animal feed. With increasing ethanol production from corn in US, the distiller's grain will be exported all over the world at practically dirt price and, if imported in bulk, can be a good source of animal feed in India.

The primary byproduct of wet milling is starch. It is recovered in purified form in a yield of 67% to 69% of corn dry substance with a recovery efficiency of 93 to 96% of the contained starch. Starch and oil in the wet milling process amount to about one-third of the original corn dry substance. These materials are sold exclusively as ingredients for animal feeds. The germ can be ground into meal and makes an excellent animal feed. Nearly one-fourth of the cornstarch produced is sold as starch products; more than three-fourths is sold as hydrolyzed products, corn syrups, and dextrose.

The majorities of corn proteins are zeins (storage proteins) and are found encapsulated in rather rigid protein bodies. The proteins in corn called gluten can be ground into gluten meal. Gluten meal is protein-rich and is used as animal feed primarily poultry. The fiber in corn, much of which comes from hulls, is made into a medium-energy, medium-protein feed product called corn gluten feed.

Corn oil is commercially produced only from corn germ isolated by dry or wet milling. The dry milling process accounts for about 10% of the corn oil production. Oil is recovered from corn germ by expelling, solvent extraction, or a combination of expelling and extracting. Wet milled germ is perfectly expelled from an oil content of 50 to 60% down to 20 to 25% and finally extracted with hexane to a residual oil content of 1 to 2 % in the sent corn germ flakes. The oil content is principally determined by the proportion of germ, which has relatively high amount of oil. Among cereals, corn has the largest germ (10% of the corn kernel), and highest oil content (about 25%).

The following corn-based secondary agriculture industries offer potential for India:

- Wet milling technology is available in India. It can be exploited to develop corn into many food and feed products, industrial alcohols (ethanol) and solvents.
- India imports huge amount of cooking oil. Oil from corn can be supplemented with other vegetable oils to meet vegetable oils need of the country.
- Corn flakes, corn pops, corn studdles, corn chips.
- Corn ingredients (gluten, germ, hulls, etc) are an excellent source of various animal feeds.
- At the village level, use of mini-mills can be promoted to make corn flour, animal feed and other products of the dry milling process to meet local needs.
- Corn stocks can be used as fiber while corncob can be converted in to Xyletol, a low calorie sweetener.

Table 9: Major Industrial Products from Corn

Sweeteners		
Anhydrous Dextrose	Glucose Solids	High Maltose Syrup
Dextrose	HFCS 42	Liquid Dextrose
Glucose	HFCS 55	Maltodextrin
Glucose Blends	HFCS 90	Xyletol
Starches		
Corn Starch (Modified) & Derivatives		
Corn Starch (Unmodified)		
Tapioca/Manioc/Yucca Starch		
Co-Products		
Corn Oil		
Corn Gluten Feed		
Corn Gluten Meal		
Other		
Adhesives	Dextrin	FOS
Baking Mixes	Emulsifiers	Polyols
Caramel Color	Fats	Sorbitol

7.2d Cereal Bran & Pulse Husks and their Byproducts

India ranks second in the production of cereals in the world after China and is the leading global producer of pulses (13 million tones out of 210 million tons produced world wide). Cereals in general constitute around 70-85% starch, 6-12% protein, 7-8% dietary fiber, 1-2% lipid and 1-2% minerals, phytic acid and phenolics. Pulses contain less amount of starch than cereals (50-70%) but more protein (14-24%) and dietary fiber (12-22%). Cereals are low in essential amino acid lysine and pulses are low in methionine but taken together provide almost a balanced diet. Bran constitutes 8% of total cereal and husk is 12% of total pulse and both are primary by-products from the milling industry of cereals and pulses.

Cereal bran and pulse husk are used as animal fodder. Even though exact statistics are not available, the total amount of processed (cereal bran and pulse husks) wastes in the world roughly 150-200 million tons of cereal bran and 20-25 million tons of pulse husk are calculated to be generated through milling industry. Many bioactive compounds such as (a) dietary fiber, (b) phenolic compounds and (c) enzymes such as β -amylase, xylanase, protease, peroxidase and polyphenol oxidase can be obtained from

cereal brans and pulse husks which can be used in food, flavor, cosmetic and pharmaceutical industries.

In India many small-scale cereal and pulse milling industries are operating in different states and, according to CFTRI, they produce about 16 and 1.5 million tones of cereal brans and pulse husks, respectively. Since most of the bran and pulse husks are from unorganized sectors, exact statistics are not available. India can utilize these byproducts to isolate bioactive and high valued molecules.

Dietary fiber: Dietary fiber is a group of plant polysaccharides not digested by human digestive enzymes. However, they have many nutritional benefits with respect to alleviation of certain diseases such as diabetes, atherosclerosis and colon cancer. These dietary fibers consists of polysaccharides such as arabinoxylans, 1,3/1,4- β -D-glucans, arabino-galactoproteins and cellulose. Dietary fibers are much in demand as a food supplement World over.

Arabinoxylans are the parent biomolecules from which several bioactive xylo-oligosaccharides can be obtained and these can be utilized as probiotics i.e. compounds, which can stimulate the beneficial bacteria such as bifidobacteria and

lactobacilli. 1,3/1,4- β -D-glucans have a role in immune response. Arabinogalactoproteins are present in very small amount and can stimulate the immune system. The above compounds can be isolated from cereal bran and pulse husks by appropriate methods for various end uses.

Phenolic Compounds: Phenolic compounds such as ferulic acid (3-methoxy-4-hydroxy cinnamic acid) and coumaric acid (4-hydroxy cinnamic acid), caffeic acid (3, 4-dihydroxy cinnamic acid) and tannins (water soluble gallic acid polymers) are enriched in cereal brans and pulse husks. These are very high valued compounds especially ferulic acid, which is the precursor of the universally used flavor compounds such as vanillin (3-methoxy, 4-hydroxy benzaldehyde), vanillic acid (3-methoxy, 4-hydroxy benzoic acid) and 4-vinyl guaicol. The current demand for vanillin in India is primarily met via import. CFTRI needs to take a lead in this direction and develop the necessary technology for the private sector. Phenolic acids especially ferulic acid and ferulic acid containing polymers can be used as antioxidant, antitumorogenic, anticarcinogenic and antifungal agents and can be thus incorporated in different health food formulations.

β -amylase (a starch degrading exoenzyme) and xylanase (acts to release xylo-oligosaccharides) are present in cereal bran and pulse husk. In addition protease, laccase, peroxidase, polyphenol oxidase are present in significant amounts in green gram husks and wheat germ. These enzymes are produced in Western countries from such raw materials in bulk

quantities for the food processing industries. Amylase, xylanase, alpha glucosidase, and ferulic acid esterase can be used in brewing, bread making, and confectionery and health food industries. Peroxidase from soy husk has significant industrial potential and is being produced in USA.

7.2e Vegetable Oils and its Byproducts:

The vegetable oil industry with a turn over of Rs. 70,000 crores per year generates a number of waste products which are sold to soap industry at a very small price. Aqueous sludges of gums, waxes and soap are being combined and sold to soap industry for the production of fatty acids. Deodoriser distillates are also being sold at a very low price. However, these waste products if purified gets added value (Rs.40-6,000/kg) and can fetch prices of 4-60 times the price of their starting waste products (Rs.10-60/kg) with a turnover of additional Rs. 10,000 crores annually. Therefore, there is a huge potential in India for recovering nutraceuticals such as lecithin, tocopherols, tocotrienols, phytosterols, oryzanol, isoflavones, protein isolates, flavours from the grain waste products.

Phytosterols from Vegetable Oils: The global demand for phytosterol will reach to the tune of 10,000 tons in 2008 at a cost of \$ 250 million. India produces 70 lakh tons of vegetable oil. The phytosterols can be obtained from these oils during refining process. These phytosterols in turn can be exploited for nutraceutical value. Some of the important phytosterols are stigmasterols, β -sitosterol, campesterol.

Table 10: Example of Some Value-added Products from vegetable oil industry

Oil seeds	Primary Product	Secondary Products	Value Added Products
Selling Price	Rs.40-130/kg	Rs.5-10/kg	Rs.40-6,000/kg
Soybean	Soya bean oil	Gum sludge, deodorizer distillate, soap stock Deoiled cake	Soy protein, isoflavones, lecithin, tocopherol, fatty acids
Cotton seed	Cotton seed oil	Gum sludge, Deodourizer distillate, soapstock Deoiled cake	Protein, gossypol, fatty acids and lecithin

Sun-flower	Sun-flower oil	Gum sludge, deodourizer distillate, soapstock Deoiled cake	Sunflower seed protein isolate, lecithin, tocopherol concentrate, wax and fatty acids
Rape–mustard seed (expeller cake)	Mustard oil	Gum sludge, deodourizer distillate, soapstock Deoiled cake	Mustard seed protein isolate, glucosinolate concentrate, lecithin, tocopherols
Palm Fruit	Palm oil Palm kernel oil	Gum sludge, deodourizer distillate, soapstock Deoiled cake	Beta-carotene and tocotrienol, palm stearin, palmitic and oleic acids, lecithin and carotenoids from pressed palm fruit cake
Rice	Rice bran oil and chemically-refined oils	Gum sludge, Wax sludge, deodorizer distillate, fatty acids, soapstock Deoiled cake	Rice bran protein isolate, coenzyme Q10, rice bran fibre for food purposes, lecithin, oryzanol, tocotrienols, squalene, phytosterols, wax and fatty acids

Tocotrienols from rice bran oil: Tocotrienols, the isomers of tocopherols are similar to vitamin E. They have antioxidant activity with many health benefits in preventing stroke-induced injuries, reverse the arterial blockage, have anti-cancer activity, reduce cholesterol and reduces relative risk for type-2 diabetes. Most of the studies have been carried out using tocotrienols from palm oil. Rice bran oil also contains tocotrienols. India produces about 7.2 lakh tones of edible grade rice bran oil. During refining of the oil, the tocols are partially distilled into the DOD. From this, there is a potential of recovering 216 tons of tocotrienol annually. The process of extracting tocotrienols from DOD needs to be developed.

Omega-3 fatty acids: The nutritional importance of omega-3 rich oils has been realized all over the World. The sale of essential fatty acids market grew to \$ 440 million/year in USA alone. About 65 percent (\$285 million) of this market was accounted by fish oil-based products and the rest by plant materials such as flax and borage oils. In India there is no major fish oil producing Industry at present with the exception of a small plant in Kerala, while the use of this product is increasing exponentially offering great opportunity for India, particularly if it is made from vegetarian source (see below).

The explosive growth of functional foods with added fish oil in the form of fish oil powders has occurred. First product with enriched fish oil

powders was in the form of yoghurt. Since then there have been many omega-3 food inventions ranging from breads, milk, and juices to chocolates. Currently, food manufacturers are also exploring sourcing of omega-3 from plants like flax seed oils. The market for omega-3 fatty acids in India is still in infancy, but likely to grow as awareness on its health benefits are made known to public. The conservative estimate for current fish oil market in India is estimated to be around Rs. 250 crores.

A pilot plant for producing omega 3 fatty acids enriched fish oil with production capacity of 12 tons/annum has been commissioned. The company achieved overall purity of 70 % as envisaged with an yield of 15 % while the target was around 12 %. The only Indian company supplying the material with above purity in three different forms, namely, triglycerides, methyl ester and powder form. The triglycerides form is a value added product and with almost double the price in international market. For powder form the company is in advance stage of setting up the pilot plant with TIFAC support.

For European countries the company has plans to sell the product in ethyl ester form, as the methyl ester form is not acceptable there. The company has already sold about 21 tons of material to various countries in last fiscal year at a price of about 154 lakhs. India needs to

develop several plants to meet the national and international demands of this essential fatty acid with focus on vegetable source (see below).

Flax omega-3 fatty acid: *Camelina Sativa* - also known as wild flax, German sesame, or Siberian oilseed - is an ancient oleaginous (oil-bearing) plant from the *Cruciferae* family, which has been domesticated and extensively used in Europe for several thousand years. The seed oil "Gold of pleasure" contains up to 45 % of omega-3 fatty acids, as well as a unique antioxidant complex making the oil very stable and resistant to heat and rancidity. Unlike any other omega-3 oil, this extraordinary blend of beneficial polyunsaturated fatty acids and high oxidative stability makes Gold of pleasure oil an excellent, versatile overall source of both heart-healthy omega-3 fats and powerful antioxidants, including tocopherols, carotenoids, and phosphatides. This species can be grown easily in Northern India producing this valuable product for International Market at a price of Rs. 500-800/Liter. The prospects for flax seed oil at a potential of 39,000 tons (Rs. 390 crores at Rs.100/kg oil) diverted towards edible oil from the present use in paint industry.

7.3 Example of the Scale of Secondary Agriculture Products Industries Based on Grains

ADM is a classical example of primary grain/oil by-product processing industry, partnering with such industries can allow realization of full potential of the Indian Secondary Agriculture industry. There is no grain processing industry in India at present to come close to this scale of operation. Such a scale of activity allows production of a variety of secondary agriculture products at a highly competitive price for global distribution. ADM is able to recover the modified components and provide value to all the co products (not byproducts) produced by various major crops.

ADM is first as an agricultural processor and a producer of food and feed products throughout the world. ADM produces the amino acids lysine, tryptophan, and threonine; the organic acids: citric, lactic and glucono delta lactone; the industrial and food thickener, xanthan gum; and the vitamin, riboflavin. Also in the corn processing side ADM developed crystalline fructose, which uses an improved chromatographic separation technique developed originally for the production of 55% high fructose corn syrup.

ADM processes most of the major vegetable oils. The list includes: soybean oil, corn oil, rapeseed, flax, peanut oil, cottonseed oil, palm oil, and canola. It is the world's largest soybean oil processor, wheat miller, and corn processor. It processes: 3 ha of maize per minute, 8 ha of soybeans per minute, 5 ha of wheat per minute. It is done in 190 processing plants in the US and 88 foreign plants. They have 37 domestic and 9 foreign oil seed crushing plants processing 84,000 tones per day. A network of 142 elevators, 62 domestic terminal and river loading facilities that have a combined storage capacity of 100 million bushels supports these processing plants. In addition they operate three corn wet mills and two dry mills in the US that process 1.6 million bushels of day. These facilities create a river of carbohydrates that ADM uses to produce over 100 different products using chemical, physical and fermentation technologies. The incoming grains are separated into their major components and purified and modified into products like ethanol, citric acid, xanthan gum, soy proteins, vitamin E, and isoflavones.

This storage and processing capacity of ADM, couple with a distribution network that includes 42 ocean ships, 11,000 rail cars, 2000 barges, and 1000 trucks, puts ADM in a unique position to take advantage of the new revolution of genetically engineered crops with improved functional traits. ADM has the capability to identity preserve a new crop through collection, distribution, and processing

Recent line of secondary agriculture products from ADM include:

- **Vitamin C.** Produced from a new two-stage fermentation based process to 2-keto-gulonic acid, which is then chemically converted to vitamin C.
- **Biotin.** This is a new fermentation based product from a patented, genetically engineered organism.
- **Astaxanthin.** This is a pigment found in natural salmon and trout that gives the fish its pink color. In farmed salmon and trout it must be added to the diet. ADM is producing a yeast that contains the pigment. The yeast is fed to the salmon direct and provides part of the fishes protein needs also. The competitive astaxanthin is produced synthetically.
- **Isoleucine.** This is a critical amino acid for animal feeds. A new genetically engineered organism is being used by ADM to produce this amino acid.
- **Zeaxanthin.** A pigment used in shrimp farming is in development.

- **Lutein.** Another nutraceutical to be produced by fermentation.
- **Ethyl lactate.** This is an environmentally friendly solvent that can replace many chlorinate hydrocarbons. It is currently in production at ADM.
- **Polyols.** In addition to our sorbitol stream ADM will be making manitol next year from a new facility and are developing new processes for glycerol, propylene glycol, and ethylene glycol.
- **Organic acids.** A number of organic acids are in development. The nutraceutical and pigment areas will provide higher margin products.
- **Biodegradable Plastics.** This is a new emerging multibillion \$ industry.

Obviously, significant technologies are involved in these processes, but the benefits outweigh the cost. ADM alone employs over 26,000 workers and operates more than 250 processing plants around the world. In India some progress has been made in this area as Continuous Solvent Extraction Plants from Germany based on the Rotary Extractor and DTDC technology have been started. Using refining process of oils incorporating Westphalia Centrifugal Systems, Continuous Bleachers, Dewaxing Systems and double shell Continuous Deodorizers, new plants need to be build to meet the growing demands in the country and to tap the export potential.

7.4 Example of Canada's Grain-Based Products Industry

Canada's grain-based products industry, as an example, is very large and diverse for the small size of the country. It includes flour milling, pasta, baking, biscuit and cereal manufacturing sectors that make a wide range of food and non-food products. This industry is efficient and competitive. Within last 12 years Canada has become a major producer and exporter of Canola (mustered seeds) and more recently of lantle, even exporting to India Dal using Indian made Dal Mills.

The Canadian flour milling industry primarily mill wheat and other cereal grains into flour, feed for animals, and other products. Some mills also blend flour into bakery mixes. The industry is closely linked with the baking, biscuit and breakfast cereal manufacturing industries, which collectively use more than 50 per cent of all milled cereal products consumed in Canada.

Canada produces an abundance of durum

wheat, which, when milled into semolina flour, is the primary ingredient in pasta. Pasta is easy to prepare, versatile and an excellent value. It is also rich in proteins, high in minerals such as iron, phosphorous and vitamins, and very easily digested. Canada exports durum wheat to many of the world's top pasta producers, such as Italy and Turkey.

The dry pasta industry involves the manufacturing of products often referred to as long goods or short goods depending on their shape. Long goods, often referred to as vermicelli, include spaghetti, capilli, linguini, vermicelli, angel hair and fettuccini. Short goods, often referred to as macaroni, include macaroni, penne, rigatoni, fusilli and ziti. There are also many specialty or novelty shapes such as bow ties, shells, cannelloni, lasagna and wheels. In addition, some pastas now include spinach and other vegetable ingredients. There are over 50 kinds of pasta products in the market.

Canada manufactures plain and fancy biscuits, which include mallows and sandwich-type biscuits, snaps, soda biscuits, packaged cookies, crackers, fruit bars, graham wafers, ice cream cones and sugar wafers. Recently some sugar-free biscuits are making an entry in the market. With almost 30% of the Indian population being hyperglycemic due to over consumption of sugar, there is an urgent need of such products. Currently no manufacturer is making products for almost 300 million potential customers in this segment in India.

The bakery industry manufactures all types of bread, rolls, pizza dough/crusts, cakes, pies, doughnuts, muffins, pastries (uncooked, refrigerated/ frozen), wafers and matzo baking. Retail bakers produce and sell and cater to the demand for fresh-baked goods such as bread, rolls and pastries. This area is fast growing in India and much improvement in quality is needed to meet the international standards for which some technologies may have to be imported. For namesake many such products are made but due to inappropriate ingredients and technologies, the final product is of very poor quality.

The prepared flour mix and breakfast cereal industry in Canada has two sectors. The prepared flour mix sector manufactures cookie, cake, doughnut, pancake and pastry mixes. The breakfast cereal sector manufactures cereals, either uncooked or ready-to-eat. Cake and pastry flour is milled from soft, white wheat. All-purpose flour is milled from hard wheat. Blends of these wheats are used extensively in these

sectors. Indian flourmills can take some of these examples and develop brand name premixed flour for various baking needs of primarily urban society.

The Canadian Grain Commission's Grain Research Laboratory is the major centre for applied and basic research on the quality of a variety of grains. This laboratory also conducts studies on commercial processing of grains, using its pilot-scale malting plant, flourmill and bakery, noodle processor and small-scale pasta press. Scientists are developing new durum wheat varieties with extra gluten strength to fit the needs of the pasta-making world.

Since 1960, enzymes have dramatically changed the starch industry and permitted the development of entirely new products. The success of enzymes in this application provides a good example of the advantages they may bring to other applications. On the one hand, grain millers use enzymes to convert starch-containing grains, such as corn, wheat, and tapioca, into value-added food and industrial ingredients.

In starch processing, naturally occurring starch is converted into dextrose and other syrups by controlled hydrolysis. The starch may also come from corn, other grains, or other sources such as potato. The historical process used acid combined with high temperatures and pressures to accomplish the same reaction that enzymes now perform under relatively mild conditions. One of the benefits offered by enzymatic conversion is the prevention of off-colors and flavors in addition to increasing dextrose yield from about 86% up to 97%.

The enzymes alpha-amylase, glucoamylase and glucose isomerase convert starch to high fructose corn syrup (HFCS). Alpha-amylase is used to liquefy starch slurry so that the starch is solubilized and processed for the next steps. Glucoamylase saccharifies the gravy-like dextrins, hydrolyzing the polymers into their individual dextrose units. Successive units are cleaved off the ends of dextrins, including those at amylopectin branch points. Dextrose produced by the glucoamylase may be processed into finished syrup, dry dextrose, fermented to ethanol for fuel or beverage use, or converted to fructose. Glucose isomerase rearranges dextrose to fructose, an isomer that is chemically similar but almost twice as sweet as dextrose. The enzyme is immobilized on a solid, granular carrier held in a reactor and dextrose is passed through it.

The scientists have replaced the first generation products for liquefaction (the process of turning starches to liquid), saccharification (the conversion of liquefied starches to sugars), and isomerization (the conversion of glucose into fructose) processes with more efficient and better-targeted enzymes. Genencor applies its technological expertise to produce more effective, next generation products. These technologies need to be developed in India to add value to carbohydrate biomass, the most valuable bioresource.

Fuel from grain: Significant amount of ethanol is currently being produced from grain and the process has become the main cause of food price increase in last one year. Production of fuel from grain is neither economical for India nor it is recommended as it competes with the food. India needs to make ethanol from sugarcane to add further value to this commodity and from lignocellulosic biomass (see below). To avoid adulteration of such fuel in to food chain, a color dye must be added to distilled alcohols for fuel use only. As discussed above, this is not a recommended path for India to follow.

Products From Ethanol Fermentation:

1. **C02:** One-half of the fermenting sugar is converted to carbon dioxide. It can be used for industrial application or in greenhouses for increasing plant growth.
2. **Alcohol:** The other half of the fermenting sugar is converted to ethyl alcohol. Since it contains all the esters, and aldehydes, it is not good for drinking, but is a very good fuel.
3. **Distiller's Grain:** Since most of the protein is left in the solids, the distiller's grain becomes a high-quality feed for livestock. Protein is 28-30%; fiber is 12-13%; and moisture is 8-12%. It can be used as a supplement to increase the protein in other feeds. USA will be the largest producer of grain alcohol in next three years and delivering huge quantities of distiller's grain to the World market at a dirt price.
4. **Chemicals:** Alcohol can be further converted in to a variety of other industrial chemicals. India Glycols Ltd. making alcohol from sugarcane juice is converting this alcohol in other chemicals.

7.5 Potential of Secondary Agriculture Products from Grains in India

The current system of grain procurement, storage and distribution has stabilized the supply: demand ratio, but time has come to look at the value of this model critically in the modern "open" economy. Privatization of this process will reduce storage waste, produce grain byproducts and create new industries providing jobs and growing agro-based industries. How significantly valuable products can be generated from the by-products of grain industry, is evident from a recent report from Australia. Modified starches could be used to make chemicals, solvents and acids. Grain products could also be used to make shampoos, cosmetics and soaps. In future the greatest growth in demand will be for biofuels, starches, pharmaceuticals and for biodegradable plastics making products such as shopping bags. The report predicts demand for Australian grain could grow by more than 500 % in next 20 years-- five or six times what is now required.

Adhesives: Adhesives are major products used for various fabrications and processing industries. They are mostly derived from Petrochemical by-products. Chemically modified linseed oil where the linoleic acid has been changed to a conjugated double bond, makes the oil more reactive, like the tung oil, but at a much lower cost. It is an ingredient in adhesives for fiberboards. It can also be used for inks and polymers. ADM processes most of the major vegetable oils and produces a variety of adhesives. The list includes: soybean oil, corn oil, rapeseed, flax oil, peanut oil, cotton seed oil, palm oil, and canola oil.

Cosmetics: The cosmetics and toiletries industry alone comprises over \$60 billion market Worldwide and uses approximately 4,000 different additives. A number of cereal derivatives are already being produced commercially and used in cosmetic formulations by many companies including Active Organics, Eastman, Laboratoires Sérobiologiques, McIntyre, R.I.T.A, Roche, and Universal Preserv-A-Chem. Recent development of the "green" cosmetics market, as consumers search for environmentally friendly bio-products, has opened up new opportunities. The cosmetics and toiletries industry uses many types of raw materials including emulsifiers, emollients, preservatives, binders, stabilizers, wetting agents, dispersants, foaming agents, pearlizers, gelling/stiffening agents, surfactants, and

viscosity builders, where cereal-derived compounds play a significant role. Even simple chlorophyll extracted from Spinach leaves has significant market as an antioxidant. India can take part in this evolving area and be competitive in the World Market.

Glycerin (glycerol): Glycerin is produced by adding alkalies to fats and oils. It is found in the stillage of wheat and corn. Glycerin is generally produced as a byproduct of soap and fatty acid manufacture. It reacts with fatty acids to form monoglycerides that act as emulsifiers and stabilizers. Glycerin is also used in a range of food products including colorings, flavorings, liqueurs and confectionaries. It acts as a heat transfer medium for frozen foods, a crystallization preventer in frozen eggs, a humectant in dry fruit and an agent for smoothness and body development in chocolate syrups and distilled liquors.

Glycerin is used as a solvent, humectant, plasticizer, emollient or sweetener and has over 1000 uses in pharmaceuticals, cosmetics, foods (e.g. baked goods, marshmallows, candy), explosives, textiles, packaging and other industries. Glycerin helps to keep creamy products soft by absorbing moisture and makes spreading easier. Some of the many cosmetic and toiletry products glycerin is found include hand creams and lotions, hair spray, liquid facial foundations, skin fresheners, toothpaste, rouge, freckle creams, facial masks, perfumes and mouthwashes. The world market for glycerol is very large (currently estimated to be greater than a \$2 Billion a year) and India should be able to compete in this market.

Glycerides: Glycerides consist of a large class of compounds that are esters of glycerin. They are generally manufactured synthetically. However, they are present in wheat germ as mono-, di-, and tri-glycerides and marketed under the trade names Vita-Cos and Wickenol. Glycerides are used in cosmetics such as lipsticks, creams, lotions, and pigmented products as texturizers and emollients. The demand for these compounds is likely to grow in India as the consumer demand for better cosmetics increases.

Polymers: A number of derivatives from cereals have application in biodegradable polymers. An example is pullulan, which may be derived from corn products using the fungus *Aureobasidium*. Pullulan can be made into films, nylon-like fibers and polystyrene-like compression moldings that have application in food, pharmaceuticals,

cosmetics and other industries. The world market for pullulan is approximately \$25 million U.S. and at present this is produced by starch fermentation.

Xylitol: Xylitol is a sweetener that is primarily produced in Finland using acid-treated fibers of birch wood. Xylitol can also be made from chemical conversion of the xylan found in corn fiber. China is making this sugar from hydrolysis of corncobs. It is used in chewing gums. According to Dr. Timothy Leathers at USDA, there may be potential for expanding the current world market of \$28 million to include use in foodstuffs for diabetics. A number of major companies in the U.S. are exploring the commercialization of this technology.

Animal feed: India is the second largest milk producer in the World; however, the productivity per animal is very poor. This is primarily due to the poor nutrition and heat stress on the animal. The milk production can be doubled in India if

the feed quality is improved, not only to meet the growing domestic needs but for the export of processed milk products, such as cheeses and milk protein. As a result the same amount of milk can be produced with half as many animals, reducing the pressure on the food chain and increasing efficiency and value. Some progress has been made in the feed industry in India but there is much room for improvement. Similarly, the poultry and fish feed has been improved but in comparison to that used in the Western animal industries, Indian feed is very deficient in nutrition, digestibility and antioxidant properties. The bait for Tuna fishing is currently imported in the country and that too by paying high custom duty and delays in the delivery of this product. An improvement in the animal feed production area will have a direct impact on the rural economy. This will reduce the use of straw for animal feed and more valued strawboards can be prepared.

8

HORTICULTURE AND FOOD PROCESSING INDUSTRIES

8.1 Food Processing Industries in India

Food processing allows value addition to the agricultural or horticultural produce by various methods like grading, sorting and packaging, milling, preserving, extracting or purifying specific materials. The process preserves and enhances shelf life, improves quality as well as make food functionally more useful. Thus, it provides a vital linkage and synergy between the agriculture and the industry. It covers spectrum of products from various sub-sectors comprising agriculture, horticulture, plantation, animal husbandry and fisheries. Thus, it helps diversify and commercialize farming, enhance income of farmers, create markets for export of agro foods and generates employment opportunities. Through these activities, a wider range of food products could be distributed to the distant locations and sold across the country or World over. Many products for health and industrial use are also generated from naturally grown or cultivated plants.

Most agro-processing industries are focused on food and herbal medicine sector, and very few industries in India derive non-food products from agriculture (see below). Food processing was originally confined to preservation and packaging which mainly involved salting, curdling, drying, pickling, etc. However, with emerging new technologies and markets, the sector has widened its scope. It has started producing many new items like ready-to-eat food, beverages, processed and frozen fruit and vegetable products, marine and meat products, etc. Accordingly, some post-harvest infrastructure like cold storage facilities, packaging centers, irradiation facilities and

modernized abattoir for processing of various food items have evolved.

The Indian food-processing sector is very large in terms of production, consumption, export and growth prospects, but this sector of industries is highly fragmented and unorganized (see <http://www.foodindustryindia.com/newfood/>).

The Ministry of Food Processing has estimated the size of the Food Processing Industry in India at Rs. 3,500 Billion (US\$75B), including Rs. 990 B (US\$22B) of value-added products. This is a miniscule (<1%) fraction of the global food-processing sector, indicating that India is far behind in this area. This sector is estimated to grow at a rate of 9-12% in comparison to estimated GDP growth rate of 7-8%, during the eleventh five-year plan. The processing is expected to increase from current 2.2 % to over 20% during the next 20 years. The largest consumed categories of packaged foods are tea, biscuits and soft drinks.

A two-day summit "Processed Food Advantage India 2008" was organized by Confederation of Indian Industry (CII) in July, 2008 and inaugurated by the Hon'ble Minister for Food Processing Industries Shri Subodh Kant Sahai where 120 Indian and 30 foreign buyers participated. India's share of global trade in the value-added processed food sector is less than 0.03%, which is abysmal considering that globally the sector is estimated at US \$ 3.2 trillion. India, with its easy availability of raw materials and low cost of production is strategically poised to capitalize on this market.

The Food Processing Industry employs about 1.6M workers directly and 0.4M indirectly, with a total of 2 Million workers (mostly in unorganized

sector). This number is projected to increase to 35-40 M in next 20 years. The total exports of the Food Processing Industry for 2002-03 was at Rs.146 B in which marine products were the single largest constituent (40%) of the total exports of processed foods. A tax holiday for five-years for new food processing units along with other benefits in the Government budget of 2004-05 has significantly stimulated the growth of this industry.

Demand for processed and convenience food is increasing constantly because of urbanization, changing life-style and food habits. Accordingly, the private, public and co-operative sectors are engaged in this industry. The Ministry of Food Processing Industries is the key agency for developing the food-processing sector in the country. It acts as a catalyst and facilitator for attracting domestic and foreign investments towards developing large integrated processing facilities and provides some technical guidance and advice to the industry. It covers the industries that produce products from fruits and vegetables, dairy, milk, poultry, fishery, consumer food, grains, non-molasses based alcoholic drinks, aerated water and soft drinks. The objectives of the Ministry are to:

- Facilitate utilization and value addition to agricultural produce for enhancement of income of farmers.
- Minimize wastage at all stages in the food processing chain by the development of infrastructure for storage, transportation and processing of agro-food produce.
- Utilize modern technology in the food-processing sector from both domestic and external sources.
- Facilitate efficient utilization of agricultural residues and by-products of the primary agricultural produce as well as of the processed industry.
- Encourage R&D in food processing for product and process development and improved packaging.
- Provide policy support, promotional initiatives and physical facilities to promote value added exports.
- Promote rationalization of tariffs and duties relating to food processing sector.

The Government has accorded the food-processing sector a high priority and has undertaken several policy measures and initiatives. It has offered a number of fiscal reliefs and incentives as well as approved a large number of joint ventures; foreign collaborations, industrial licenses and 100%

export oriented units (EOU) proposals in different food processing areas. Some of the important steps taken in this direction are:

- Most of the processed food items have been exempted from the purview of licensing under the Industries (Development & Regulation) Act, 1951, except items reserved for small-scale sector and alcoholic beverages.
- Food processing industries are included in the list of priority sector for bank financing in order to ensure easy availability of credit.
- Automatic approval for foreign equity up to 100% for most of the processed food items, except alcohol and beer and those reserved for small-scale sector (subject to certain conditions).
- Excise duty on ready-to-eat packaged foods, instant food mixes like dosa and idli mixes, aerated drinks, as well as on fruits and vegetables processing units, have been reduced. These duties need to be completely eliminated to allow further growth in this sector.

Food Safety Standard Act 2006 (Integrated Food Law), has recently been enacted to:

- Consolidate the laws relating to food,
- Establish the Food Safety and Standards Authority of India for laying down science-based standards for articles of food.
- Regulate manufacture, storage, distribution, sale and import of food articles with a view to ensure availability of safe and wholesome food for human consumption, and
- Pool infrastructure, manpower and testing facilities for better standard enforcement.

The primary aim is to achieve consumer confidence in the quality and safety of produced and processed food, sold locally or exported. As a result of such measures, the industry has witnessed rapid growth. The installed capacity of fruits and vegetables processing sector has increased from 11 lakh tons in 1993 to 21 lakh tons in 2006 and 25 lakh tons in 2007. Since the utilization of fruits and vegetables for processing is only about 2.20 per cent of the total production, it suggests a significant need to grow this sector more rapidly.

Despite a dedicated Ministry of Food Processing a desperate situation in this sector seems to exist as shown by the following two e-mails received by TACSA.

----- Original Message -----

From:<mailto:sharmann@vsnl.com>Sharmann
To:<mailto:b-patil@tamu.edu>Bhimanagouda Patil
Sent: Saturday, March 22, 2008 9:27 AM
Subject: Rural poor in India

Dear Mr. Patil,
 You hold such a high post in R & D and we have 365,000 tons of pineapple, 15,000 tons of passion fruit, 15,000 tons of ginger and 25,000 tons of turmeric going waste in north east of India, there is no electricity
 can you suggest something, a Portable processing unit and its supplier/any other technology/Can banana peel be used to make any product/
 90% of khajoor grown in Kutch is thrown away because it is not sweet?
 You owe it to the poor people of India to give some solution=H.S.sharma,FAO(UNO)
 Consultant ex
 M-9873020599/fax 0124-4078342/E<sharmann@vsnl.com>.

 Every yr some where in India thousand of tons tomato goes to waste, as price is 25 paisa/Kg in Karnool in 2008, in Chindwara, in 2007, & in dindigul in 2006. it is not remunerative enough for farmer to pluck it and transport it. They let it wrought on plants. Surely there must be some solution at your end or you know whom should I contact!

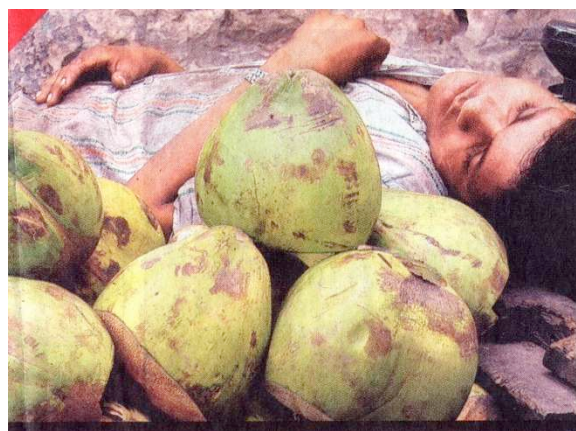


Figure 7: A coconut seller has siesta while selling fresh coconuts. Even if he sold all his produce he can not make Rs 50 profit in one day. (Picture from Hindustan Times)

It was a pleasure to see that a new industry has developed recently to bottle coconut water as "CocoJal" and is marketing this product all-over India. This product has

international potential for sale, and may be this coconut seller can find an employment in such an industry. This is precisely the kind of Secondary Agriculture Industries that India needs to develop based on their agriculture strength.

(Note: Seventeen states grow coconut in India yet the coconut oil is currently imported)

One of the TACSA members who is in close contact with the agro-processing industries has made the following observations:

1. The concept of food safety and hygiene in India is largely missing and the agriculture policy does not encourage the quality production, emphasis has been on quantity. Since India is a part of WTO which requires sanitary and phytosanitary measures India has to adopt Codex alimentarius standards for any food products for export.
2. Lack of infrastructure (cold storage, processing facilities) leads to quality degradation and in-turn leads to value erosion.
3. In India, hygiene is apparently taxed. If one wants to do any value addition, there are so many hurdles and high cost of operation, that people prefer to follow the outdated ways as it becomes issue of survival for a small business, and unregulated sector continue to proliferate.
4. For value addition, the knowledge base is very poor and some times outdated, R&D for value added product is very weak. Commercialization of patents from most public institutions is negligible and the patents obtained/filed have not been assessed for economic reality and market needs in most cases.
5. Human Resource is in short supply because working in agriculture and food sector means representing or accepting that the individual is not competent to work in more valued jobs. As a result, the younger generation is not very keen to work for the agriculture sector.
6. Policy makers treat agriculture as a political activity rather than a business activity, and that is why decisions such as commodity exchanges, rural

warehouses, rural electrification, etc. take for ever to get political support. Before the commodity exchange could be firmly established Government has decided to levy tax on this activity.

7. Education system in agriculture is totally under government control. Most of the agriculture curricula are outdated and the facilities are ill equipped to meet the emerging needs of new generation agro-industries.
8. R&D has no direct relation with the economics and trade in agro-commodities. The critical data is not available and agri-marketing is very poor.
9. Much less progress has been made on the input side of agriculture (particularly micro-nutrition) besides increasing the supply of fertilizers and irrigation. Hence, the productivity per unit land remains low.
10. There is a long road from farm to grocer, and too many hurdles to cross this path.
 - [Investment Opportunities in Uttaranchal, Forest and Rural Development Branch, Uttaranchal Secretariat, Dehradun.]

A synopsis of Food Processing Industry in India is provided in a published report (India Infoline). This report consists of key chapters on: Food & Agriculture: Key Statistics and Trends; Projects

in Food Processing Sector; Industry Segmentation as per MOFP; Opportunities & Constraints to growth of Food Processing Industry; Policy Initiatives; Recent Government Initiatives, Enactment of Processed Food Development; Industries included in this report are:

- Processed Fruits & Vegetables
- Meat and Meat byproducts
- Grain Processing
- Meat & Poultry Processing
- Fisheries, Marine products
- Milk & Milk Products
- Culinary – Cooking aids, Ready-to-Eat, Ready-to-Cook
- Beverages-Fruit Based, Carbonated Drinks, Malt Based
- Staples- Bread, Wheat Flour, Salt
- Snack foods- Namkeens, Biscuits
- Confectionery

The report also included few leading player's activity profiles. All these industries, except Dabur focus on basic food commodities with little value addition. The Biscuits factories are working on a margin of 4-5% and TACSA visited two such industries in Uttarakhand. At the same time, enormous opportunity is available to make hypoglycemic products to cater to over 300 Million diabetic and potential diabetic population in India. To tap this opportunity, a close cooperation with food processing institutes and the industry is required providing an example of direct benefit from such collaboration.

Agro Foods Pvt Ltd	HLL Ltd	Parle Products Pvt Ltd
Britannia Industries Ltd	Haldiram Pvt Ltd	PepsiCo Inc
Dabur India Ltd (Foods)	ITC Ltd	General Mills-Pillsbury
Dynamix Dairy Ind Ltd	MTR Foods Ltd	Surya Foods and Agro
Gits Food Products Pvt Ltd	Nestle Ltd	Tata Chemicals Ltd
Godrej Industries Ltd-Foods Division	Parle Agro Pvt Ltd	

8.2 Overview of the Fruits and Vegetables Sector in India

India with its wide variability of climate and soil produces a wide range of horticultural crops including fruits and vegetables. Recent efforts have been rewarding in terms of increased production and productivity and availability of much larger volumes of fruits and vegetables. As a result India has emerged as the second largest producer of fruits and vegetables in the World.

Fruits: India produces over 46 million tons of fruits accounting for around 10% of the World's production. The country ranks first in mango, sapota and acid lime, and in recent years recorded the significant productivity in grapes. Table below summarizes the production of major fruits in the country.

Table 11: Type of Fruits grown in Different Agro climatic Zones in India

Tropical and sub-tropical regions	Mango, banana, citrus, pineapple, papaya, guava, sapota, jackfruit, litchi and grapes
Temperate	Apple, pear, peach, plum, almond and walnut
Arid Zone	Aonla, ber, annona, fig, phalsa

Table 12: Area and Production of Major Fruit Crops in India

Crop	Area (Million Ha)	Production (Million Tons)	Percentage of total production
Banana	0.62	16.45	35.3
Mango	1.56	10.64	22.8
Citrus	0.56	4.58	9.8
Papaya	0.07	1.82	3.9
Guava	0.19	1.68	3.6
Apple	0.25	1.42	3.0
Pineapple	0.08	1.26	2.7
Grapes	0.06	1.10	2.4
Litchi	0.05	0.42	0.9

Source: Ministry of Agriculture, Government of India.

Mango is the most important fruit covering 39 percent of the area accounting for almost 23 percent of total fruit production in the country. India's share in the world production of mango is about 54 percent. Banana ranks second in area covering about 13 percent of total area. Banana contributes nearly one-third of the total fruit production, but besides fresh fruit hardly any other banana products are available while there are at least 20 such products in the international markets derived from banana, let aside other industrial fiber from banana trees. Citrus ranks third in area and accounts for about 10 percent of the country's fruit production. Apple is another

major fruit in the country with production of about 1.42 million tons. There has been steady increase in the area, and production of arid zone fruits particularly ber and pomegranate as a result of development of suitable varieties and production technologies. The processing of fruits is very limited resulting in seasonal gluts and further reducing the value of the produce affecting farm economy.

Vegetables: Vegetables constitute the most important food next only to cereals and milk. India produces almost 100 MT of vegetables. Important vegetable crops grown in the country

are potato, tomato, onion, brinjal, cabbage, cauliflower, okra and peas. India occupies the first position in the production of cauliflower, second in onion and third in production of cabbage in the World. Most of these vegetables are seasonal and little effort is made in developing new varieties or technologies to widen the growing season and hence add value to these basic farm commodities. Again a close cooperation between the ICAR institutes and industries is warranted in this case.

Table 13: Area and Production of Major Vegetable Crops

Crop	Area (Million Ha)	Production (Million Tons)	Percentage of Total Production
Potato	1.41	24.00	24.9
Brinjal	0.50	7.80	8.1
Tomato	0.52	7.42	7.7
Cabbage	0.27	5.70	5.9
Onion	0.52	4.85	5.0
Cauliflower	0.27	4.70	4.9
Okra	0.36	3.42	3.5

Source: Ministry of Agriculture, Government of India

Brinjal is a major vegetable crop, and is available, like potato and onion, almost throughout the year. It contributes about 8.1 percent of the total production of vegetables followed by tomatoes (7.7 percent) and cabbage (6 percent). Among root and tuber crops, India ranks fifth in the World in area and production of potatoes and tops with 24 percent share in total vegetable production.

8.2a Fruit and Vegetable Processing

In processing and value addition in fruits and vegetables, India falls way behind the rest of the World. Fruits and vegetables have a very short shelf life. The minimal level of processing that they undergo is just packed and branded. Secondary processing to convert to pulps,

juices, pickles, concentrates, dehydrated etc. is very limited. Currently, only 2 percent of the fruits and vegetables in India go through the processing route. Secondary processing is even lower at 1.3%. The current wastages in fruits and vegetables are estimated at about 35%, the value of which is estimated to be Rs.33, 000 Crore (~\$8Billion) annually. In the absence of pre-cooling arrangements at the farm level, the farmer is not in a position to grade and store his produce in anticipation of a better price or transport to major distance. Preventing such a waste of this valuable agro-resource would justify any expenditure in this area.

As soon as a crop is harvested, it has to be rushed to the market or sold to the first available buyer or *arhtia* leading to a decline in prices during harvest time. Following harvest, it is to be transported to the market in a most rudimentary fashion. In the absence of reefer vans and cold-trucks, horticultural and agricultural produce is transported in sacks resulting in damage to fruits. It has been estimated that nearly 30-40% of the fruits get damaged during the transportation, considerably reducing the final realization by the farmer. Aggregation of produce is also done at various points by a number of dealers leading to further weeding out of damaged fruits. Processing is undertaken only if fruits and vegetables are surplus to the requirements. The quantity and quality available for processing, therefore, varies depending on the size of the crop and the requirements of consumption. The practice of producing solely for processing is to a large extent absent.

This compares poorly with processing levels for fruits and vegetables of 23 percent in China, 30 percent in Thailand and 65 percent in USA. Even, within the country, share of fruits and vegetables processed is much less when compared to other agricultural products such as milk (35%) and Marine Products (26%).

The total installed capacity of fruit and vegetable processing industry in 2005 was 2.12 million tones only, as against a total production of almost 140 million tones. Over the last few years a positive growth has been seen in the ready to serve beverages, fruit juices and pulps, dehydrated and frozen fruits and vegetable products, tomato products, pickles, convenience veg-spice pastes and processed mushrooms. However, the domestic consumption of value added fruits and vegetables remains low compared to the primary processed foods in general, and fresh vegetables and fruits in particular.

Exports: India has negligible share in the global exports of processed fruit and vegetable

products. Growth in exports of processed fruits and vegetables has also been slow, at 7% in the last decade. Figure 7 shows growth in exports of processed fruits and vegetables in the last few years). Processed fruits and vegetables to the tune of 59000 MTs valued at Rs. 1462 crores were exported from India in the year

2004-05. If processed using modern technologies, a significant value addition could occur to these farm produce creating jobs and improving rural economy. This sector needs to widen its focus beyond catering to the needs of NRI and delivering products to meet the needs of European and American markets.

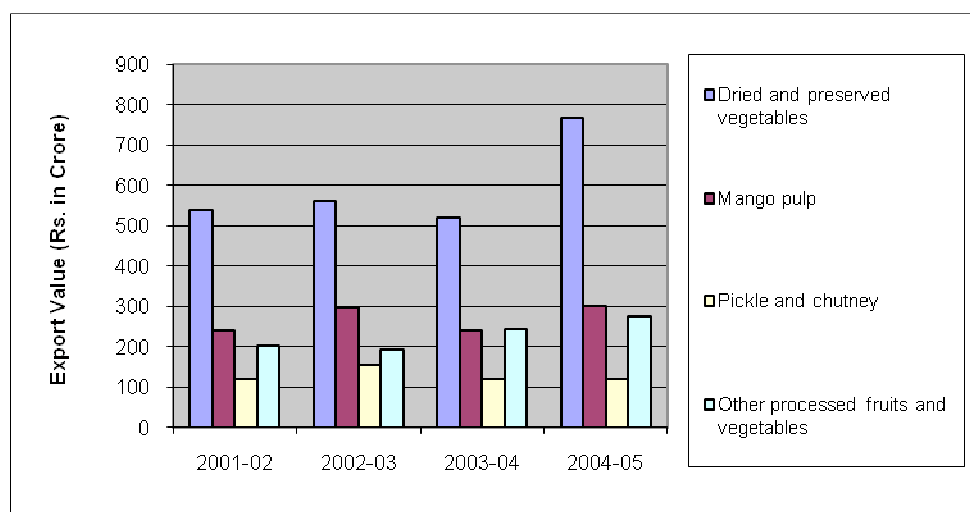


Figure 8: Growth in Export of Processed Fruit and Vegetable Products (2001-06)

China's Profile in the Global Fruits and Vegetables Market

The export value of China's fruits and vegetables (including fresh fruit, fresh vegetables, processed fruit and vegetables, fruit and vegetable juices, pulses, and tree nuts) during 2002-04, were more than double the value from a decade earlier, from \$2.3 billion to \$5.1 billion (20 times more than India). Chinese fruit and vegetable exports are mainly value-added processed products, accounting for 60 percent of the total value of fruit and vegetable exports in 2002-04 and about 12 percent of global trade while India's exports are primarily fresh produce.

Since 2003, China's apple exports have surpassed those of the United States and have made inroads into major U.S. export markets. More than 40 percent of processed fruit and vegetable exports by value go to Japan. China's apple juice exports, in contrast, have a Worldwide market with most juice exports shipped to countries outside Asia.

China's export competitiveness arises from:

- Market oriented reform policies that encourage fruit and vegetable growers.
- Lower production costs
- Efficient processing industry-
- Investment by vegetable and fruit processing companies encouraged by providing tax breaks, low cost land, or other concessions

India has moved away from subsistence levels of production of fruits and vegetables to a stage where surpluses are available though in specific pockets of the country. India's share in some of the agricultural and horticultural produce in the World is as follows:

Table 14: India's share in some agricultural and horticultural produce.

Fruit/ Vegetable	Percentage share in global production
Mangoes	54%
Cauliflower	30%
Bananas	23%
Green peas	36%
Onions	10%

Surplus production has brought in local markets difficulties accompanied by increases in levels of wastage up to 35%. As a result farmers have not been getting remunerative prices for their produce. Furthermore, by 2010, the National Horticulture Mission targets to increase the production of fruits and vegetables to 260 MT from the current 140 MT. To gainfully utilize the increased production of fruits and vegetables, these commodities need to be processed for domestic as well as export markets. Not only will this increase the income level to farmers, but also increase the shelf life of vegetables and fruits thereby reducing wastages. Without managing processing and preventing waste, simple productivity is of not much benefit to the farmer. The current wastage in fruit and vegetable sector is estimated to be of the order of \$8 Billion per year. Such a waste should justify any investment in cold storage facilities which will not cost as much as the waste in one year. In the report submitted to the Planning Commission in 2001, over two dozen terminal markets for export with full cold storage facilities were identified.

8.2b Lack of Suitable Varieties and Processing Technologies

Availability of suitable variety is one of the major factors associated with processing of many fruits and vegetables. Most Indian varieties of fruits and vegetables are not developed with processing industries in mind, and thus they are unsuitable for processing or export. Two cases in point are Nagpur oranges and Malihabad Mangoes.

The main reason for lack of suitable processable varieties is the disconnect between R&D, market and extension services of the Government Institutions. As a result, R&D is carried out in

isolation, without alignment to market requirements. Further, due to ineffective extension linkage, farming systems and technologies are not effectively disseminated and commercialized. Often, research has failed to offer saleable models and industries do not have sufficient capital to develop their own R&D.

Malihabad Mangoes

Malihabad grows traditional varieties of mango for last 300 years. However, Malihabad mangoes represent lost business, since there is hardly any processing or exports of these mangoes. The reasons being:

- Mangoes grown here have a short shelf life, which prevents their transport over long distances.
- They are too sweet for the international palate
- No suitable processing industries located close to the mango growing region.

Nagpur Oranges

Oranges from Nagpur is an example where there are gluts at harvest time, processing does not occur due to the shortage of processable varieties. The oranges from Nagpur have high bitterness level and pip content which renders them unsuitable for export or processing. New varieties have not been developed to meet these needs. The ICAR institutes need to become more engaged in the development of such varieties and developing processing technologies, including the use of the by products.

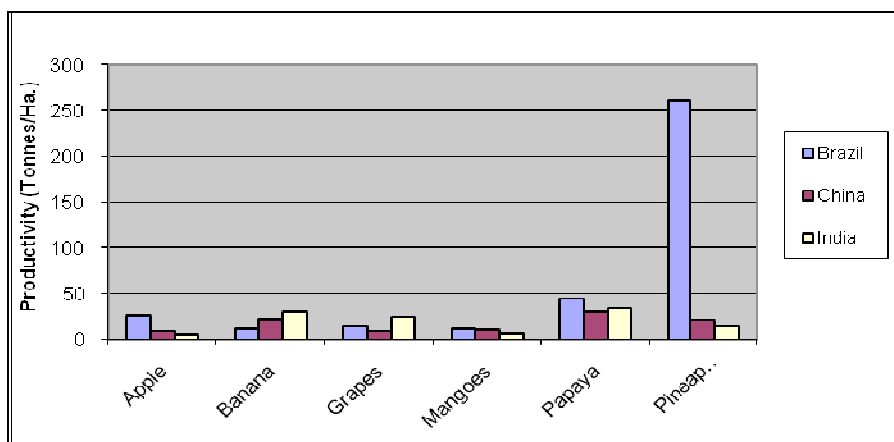


Figure 9: Fruit productivity- Comparison among Brazil, China and India

Low productivity levels: Indian yields are lower when compared to other key producers of F&V like Brazil and China (Figure 8). Exceptions can be seen in the case of Grapes and Banana,

where the yields are good as a result of introduction of new high yield varieties and their adoption by farmers.

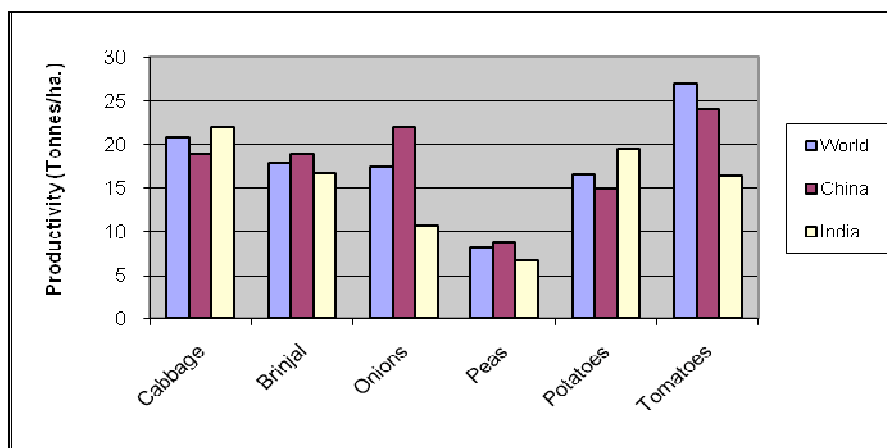


Figure 10: Productivity of Vegetables in India in comparison to China and the World

Short Production Season for Vegetables and Fruits: Short production season for Fruits and Vegetables restricts availability of raw material for fruits and vegetable processing industry. Due to this seasonal nature, assets remain idle over long periods of time. Stretching the production season of many fruit and vegetable crops will have the potential to dramatically affect availability of raw material for the processing industry. Increased use of technologies to stagger flowering, varietal changes etc. is necessary to achieve these objectives. Bringing portable units to the production area to process seasonal fruits and vegetable may help to overcome some of this problem.

Packaging: Packaging of fruits is a major area where waste can be prevented. Cost of packaging, however, is very expensive currently accounting 35-40% of the end product cost. High quality packaging needs expensive raw material and machinery. Research on packaging therefore needs to focus on arriving at low cost solutions besides permitting import of packaging material, machinery at low rates of duty, and allowing used processing and packaging machineries that can be had at as low as 20% of the cost. Import of such tools must be a priority for the country and it is in no way in competition with local manufacturer as such machineries are not manufactured at present time in India.

8.2c Rural Level Food Processing

Simple technologies that allow dehydration of fruits and vegetable using solar heat and air circulation can create significant value addition to fruits such as banana and papaya as well as vegetables such as tomatoes. Such dehydration processes can take advantage of glut in the market and create a product that has long shelf life and transportability adding value to the farm produce. Such technologies can be easily developed and made available to the remote rural areas where there is not even electric supply available, and even tribes can make use of such tools.

Marketing: Sale of fruits and vegetables as most other agricultural commodities is regulated under the Agriculture Produce Marketing Committees Act (APMC Act). In most states, the APMC Act did not allow transactions outside the *mandi*. Even in states that allow transactions outside the *mandi*, the Act stated that while procurement may be direct, companies needed to pay a *mandi* tax even if the *mandi* infrastructure is not utilized. Tax collection and free markets are independent processes, they should be addressed separately and one should not be hold responsible for other. Let the free markets decide the price and flow of goods without APMC control on the flow of farmers produce. Such controls do not exist on other industrial products marketing, and if agriculture is an industry, than it should be treated as such without artificial non-market-driven controls.

The APMC Acts of different states have become a stumbling block for markets seeking to scale up operations. Hypermarkets seeking to source bulk quantities of food and grocery have to work through intermediaries in APMC markets, and cannot deal with the farmer directly. Further, marketing of farm produce under the Act was controlled by 'arhatiyas,' or commission agents.

The market fee charges on value of produce sold do not reflect actual cost of the wholesale market and it is seen as another tax on agricultural commodities. As per the Act, waiving of market fees would only apply to specified products sold under contract farming. Direct sales would still be subject to market fee and direct buying from the farmer's premises would require a license from the State Government. This will create another level of bureaucracy further strangling the flow of raw material for processing industries.

TACSA is of the opinion that this act is an hindrance and needs to be abolished. Abolition of APMC Act would facilitate free movement of agricultural produce between different States. It is necessary to ensure that collection of all additional fees and cess in the market be withdrawn and alternative sources of revenue found for the same. Though 18 states have approved amendments to APMC Act, in most of the states, rules are yet to be notified. Uniform rules across all states is essential for increasing

inter-state flow of agro commodities and create better markets for the benefit of the farmers.

States such as Madhya Pradesh, Rajasthan and Uttar Pradesh had amended the APMC Act, permitting companies such as ITC Ltd to set up its e-chaupal network to procure goods. The Karnataka government has already permitted the National Dairy Development Board (NDDB) to set up an 'integrated produce market' at Bangalore for marketing fruits, vegetables and flowers. Maharashtra is also in the process of amending the APMC Act on lines of provisions in the Model Act. It would take some time for the other states to implement the model APMC Act, primarily because of their reluctance to change the existing supply lines and fear of loss in revenue collection. This area must be open to any one and not selected case by case by state Governments. There is no such regulation on other commodities in consumer market.

Export: Indian exports of fruits and vegetables comprise primarily the raw form and primary products, with lowest price realizations. The growth in this sector is relatively new as most of the export was based on spices. Among the host of reasons for low export that are stated in Table 14, the main problem is the scale of the size of farms, lack of processing and marketing. Processed fruit and vegetables have shown a low CAGR of 7 percent. Some of the key barriers to exports include:

Table 15: Key Barriers to Export of Fruits and Vegetables

Price competitiveness	Wide fluctuations in prices of Indian fruits and vegetables products as compared to South America, which offers more stable prices.
Freight costs	Freight cost and short shelf life are key constraints to success in export markets for many F&V
Phytosanitary requirements	In the post WTO period, especially since 1996-97, the complexity of SPS regime has significantly constrained market access in developed countries for Indian FRUITS AND VEGETABLES products.
Climate and seasonality	Subject to fluctuations and short season of availability
Small size of industry and participants	Large scale of turnover is essential for export operation. Indian exporters lack the scale and hence competitiveness. This leads to low investments in skill and quality, product innovation and brand building
Fragmented nature of the industry	The industry is fragmented. Hence, exporters are unable to establish themselves as long-term players
Raw material supply and quality inconsistencies	Quality raw material for processing value added FRUITS AND VEGETABLES meeting international standards is not available. Even when available, the cost of raw material is very high. This is linked with the low productivity of most commodities per unit land area.
Certification	Increased compliance costs and lack of established quality parameters.

Lack of market intelligence and statistical data	Lack of information about international requirements to a large number of producers. Government needs to play a role in this area, rather than controlling supply chain via APMC act.
Packaging	Poor packaging due to high costs and low innovation in packaging. Lack of suitable packaging machineries and materials.

Example of New Zealand's Fruit and Vegetable Industry

New Zealand with innovation and expertise and leading technologies produces and export an array of premium fruit and vegetable products. The top five horticultural exports are kiwifruit (27%), apples (20%), total fresh vegetables (12%), total frozen/processed vegetables (12%). Onions (41%) and squash/Kabocha (27%) dominate fresh vegetable exports. The two main exports, kiwifruit and apples, are both World leaders. This international success has been achieved through:

- Continued research and development with a stream of new varieties that anticipate and meet the changing needs of consumers. New Zealand was first to the world market with products such as Braeburn and Royal Gala (now grown the World over) and ZESPRI™ Gold. Research is also producing fruits with greater health benefits and consumer convenience, such as citrus fruit with easily peeled rind, seedlessness and increased size.
- Novel innovations in marketing and branding.

New Zealand is also a major exporter of processed fruits and vegetables. Leading edge technology such as snap freezing to protect from nutrient loss and to retain flavour gives this sector a competitive advantage. New Zealand has demonstrated that a co-ordinated effort of research institutes, industries and farmers can build World leading agro industries.

Infrastructure

Inadequate infrastructure is recognized as a major constraint in the growth of all agro-

Processing industries: Without extensive dependable cold chains, a vital sector like FRUITS AND VEGETABLES processing industry, which is based mostly on perishable products, cannot survive and grow. Even at current level of production, wastage in fruits and vegetables is estimated at 35%, major reasons being inadequate storage, poor transportation, lack of cold chain facilities and other infrastructure support any where in the country.

Government of India has been implementing several schemes for facilitating creation of infrastructure for food processing including the following:

- Packaging Centers
- Integrated Cold Chain Facility
- Value Added Centers and
- Irradiation Facilities.

A proposal for the revisions in Food Parks project, based on their poor performance were presented by Dr. Krishankumar in his report on the Fruits and Vegetables submitted for the XI Five Year Plan (see below).

Tax System: Current high level of taxation in processed agricultural products not only acts as a disincentive for investment in this sector but also affects the competitiveness of the food products in the country. Though primary agricultural commodities including fruits and vegetables are mostly exempted from tax, processed food commodities are subject to a Central Sales Tax of 4 %. With Value Added Tax (VAT), levied by State Governments, most processed food products are taxed at 12% to 13%. Apart from VAT other state taxes such as entry tax, octroi etc. are also levied on food products. Though there has been a substantial rationalization of taxes in fruit and vegetable processing sector since 2001-02 when Central Excise Tax (CET) on processed fruits and vegetables were reduced from 16% to 0%, high taxes/ duty on raw material for packaging, packaging machinery and raw materials still affects the growth of the food-processing sector in general and fruits and vegetables processing industry in particular. Packaging materials such as glass bottles, jars, caps and closures, plastic jars, shrink-wrapping are at present levied 16% CET. The existing Import Duty on raw material for packaging (Prime tin plate, aluminum foil, paper board etc is very high (25 to 44%). Similarly, machinery for packaging attracts 20-25% duty. Cold chain infrastructure is the lifeline for the sustenance of food processing for

perishables such as F&V. CET on the cold chain equipment is currently a high 16%. If India is to build a World class Secondary Agriculture processing industry, including processing of fruits and vegetable five year complete holiday from all such taxes is required to build a strong foundation of these industries.

Lack of Proper Infrastructure for Food Processing Industry

Inadequate infrastructure is one of the major factors standing in the way of expansion of agro-food processing industries in the country. One of the major constraints experienced in the post harvest handling of all perishable agricultural commodities is the absence of an efficient cold chain, including on farm storage facility. In fact very significant losses almost to a tune of Rs 58,000 caror occur every year according to the estimates by the Ministry of Agriculture (see See Hindustan Times, April 10, 2008). These kinds of losses should encourage both Government and private sector to take initiatives and build proper storage, processing chains across the country to handle all major crops. Though several schemes are being implemented by various ministries and agencies, these initiatives are having limited success. The cold storage capacity today caters to less than 10% of the produce, this too of rudimentary nature, with over 80% designed only to handle potatoes.

This not only leads to wastage of perishable produce but also adversely affects the supply of raw material to food-processing industries. The wastage adds to the cost of raw material ultimately affecting the competitiveness of the entire Indian food processing industries. Inadequate and fragmented supply chain prevents linkages of farmers to the markets, depriving them of the opportunities offered by the emerging retail boom. There is an urgent need for technology induction facilitating use of Controlled Atmosphere Chambers, IQF facilities to be linked to the farm or collection hubs through reefer vans and ensuring an end to end cold chain for transport of perishable fruits and vegetables.

The infrastructure for primary processing and secondary processing also needs to be strengthened under a sustainable management arrangement. Several programs have been under implementation during the Tenth Five Year Plan for supporting infrastructure development. Most of these programs are fragmented, too complicated and have not delivered expected results. These schemes need to be simplified giving a flat subsidy to the private sector after completion of the project.

Micromanagement is highly cost ineffective, delays the project and breeds inefficiency in the system. The Indian Government should not work on things that are already being done in the private sector. Crop institutions should complement what is going on in the private sector and not compete with it. By avoiding duplication of efforts, the government is in a position to free up its resources on segments of agriculture that are not being pursued by private institutions. In particular Government should focus attention on one hand on people below the poverty line and those in tribal area, while supporting value-creation in agriculture, which affects the entire rural population.

Government institutions should focus on setting and enforcing standards of quality so that agriculture products are able to meet as well as differentiate themselves in the arena of quality. This exercise of setting of standard must be done in conjunction with private industry and in harmony with global standards.

8.3 High-Value Secondary Food Products

Due to the limited value addition most food products in India are sold as commodities. While more and more people are consuming value-added food products and the import of such food items is increasing. The industry holds significant export opportunities and its growth can bring immense benefits to the economy by increasing agricultural value, enhancing productivity, creating employment and raising living standards of a large number of people across the country, especially those in rural areas. Thus, there exists innumerable business opportunities in the diverse areas of agro-processing for food and non-food products. But, according to the Ministry of Food Processing the sector still remains largely untapped because of high packing costs, cultural preference of the people for fresh food, seasonal demands of raw materials, lack of adequate infrastructural facilities and quality control mechanisms. There is an urgent need to diversify the sector by fully harnessing its potential, providing greater incentives as well as creating conducive environment for more investments and overall improving the infrastructure.

There is significant potential to produce higher value secondary food products as the, need and affordability of people, particularly in the urban area increases.

- Beverage Flavors
- Essential Oils

- Massage Oils
- Flavors Concentrate
- Flavor Extract for Clear Beverages
- Flavor Extract
- Flavor Oils
- Flavor Oils for Chocolate
- Flavor Oils for Coffee & Tea
- Food Coloring
- Cotton Candy Base
- Juice Concentrates
- Pancake Syrups
- Snow Cone Syrups
- Non Dairy Frozen Dessert (Soy Milk)
- Sports Drink Powder
- Coffee Syrups
- Frostings & Icings
- Cookie Fillings
- Non Dairy Coffee Creamers
- Xylitol Non Dairy Coffee Creamers
- Xylitol Base
- Xylitol Sweetener Powder
- Xylitol Syrups
- Xylitol Snow Cone Syrups
- Xylitol Smoothies
- Xylitol Italian Soda Syrups
- Pancake Syrups Sweetened with Xylitol
- Stevia Products
- Natural Stevia Spring Water
- Stevia tea and coffee sweeteners
- Sorbet / Frozen Yogurt/ Ice Cream
- Instant Ice Creams
- Instant Frozen Yogurt Powder
- Instant Sorbet Powder
- Non Dairy Frozen Dessert (Soy Milk)
- And More.....

8.4 High Value Byproducts from Fruits and Vegetables

India being the second largest producer of fruits in the world can generate significant volumes of byproducts from the processing industries. Peel is the major waste generated from fruits. The quality (physical and chemical properties) of peel varies depending on the fruit type. Mango, Banana, Citrus, Grapes, Apple, Pear, Papaya, Custard apple, Guava, Pomegranate, Pineapple, Amla, and Mangosteen, represent examples of such a range. Accordingly, the peel content also varies from 5-50%. Depending on the area of production, quantities generated are also related. The peel undergoes rapid changes in quality and requires suitable care immediately after fruit processing; to take for the generation of secondary value added products. They can be used for production of the range of secondary

products such as pectin, mucilage, gums, anthocyanins, carotenoids, antioxidants, antimicrobials, and insecticides, fermented products or as supplementary processed products, in food formulations. However, the main limitation is actual quantity that is practically available, its processing, and final yield (its quality) that eventually decides the economic feasibility of the process. Oil from citrus and pectin from fruit peels, are classic examples. Anti bacterial and antifungal compounds as well as tannins and phenolics are some of the key products that can come out of these processing byproducts.

Their use and application in preparation of candies, glazed fruits, enzymes, oils, pectin and cosmetics are some of the proven examples, with vast scope for exploitation with great diversity of fruits available in India.

Subjecting any fruit or vegetable for processing eventually involves removal of peel (besides seeds). Thus, 'fruit peeling' contributes significantly whilst processing a fruit. Peeling is dependent on the morphology of the fruit, its size and thickness of the peel. Based on the physical and chemical characteristics of the peel, engineering aspects are dealt for mechanical separation and use for production of secondary products, from the peel.

The World market for pectin is worth \$ 300 million and growing at 5% per annum. Seven million Kg of commercial pectin in the World is used to make jelly and similar products. In fact, pectin has a range of applications such as use in jams, marmalades, preserves, as thickening agent for sauces, ketchups, flavor syrups and as texturing agents in fruit-flavored desserts etc. Similarly, the World trade of \$32.4 million estimated for oil yield (~3%) and cost of oil (\$2 per Kg), based on 50% use of peel for oil extraction.

Fruit peels are considered as the best source for a spectrum of compounds such as polyphenols, flavanoids, tannins, catechins, vitamins such as C, E, beta-carotene etc. The World demand for such nutraceuticals is estimated to be in excess of one billion \$. Further research may be carried out at Indian Institutes to reduce the cost of processing:

8.4a Wines and Other Products from Grapes

Wine industry is very large World wide generating over \$90 Billion/year in global trade. India has just learned to produce wine at a

commercial scale and the industry is in its infancy stage with a large potential for grape production and to spur auxiliary business activities. This will benefit both farmers and wine industries as well as generate significant tax revenue for the Governments both at the State as well as the Central level. Significant know how is, however, needed to produce good quality wines and collaborative ventures in this area are likely to result in better success, providing access to global markets. California and Australia are producing some of the best wines in the World competing with the well-established wine industries in Italy and France. Other recent entries are Australia, Chile and Spain. India has a great potential in this industry and some members of TACSA visited Nashik grape growing area and wineries. This industry will not develop, however, under heavy excise pressure and freedom to operate, including building export potential by marketing collaborations. Even the bottles and corks have to be imported, besides all other equipment to build this industry. Such imports should be completely duty exempted if this industry is to grow and create thousands of jobs both at the farm level and at the winery as well as in the retail sector.

Several byproducts come out of the grape processing both from seeds (grape seed oil) and skin (resveratrol, polyphenols) as well as the residues of wine distillation. Use of 100% grape skin natural color powder includes beverages, sauces, and baking, or a red wine tint. This extract can be processed with beverages, milk, chocolate, candy, and other various food items to produce health-conscious food products. This extract can also be used to dye and to color water paint. These industries can be developed in close proximity of distilleries to reduce the cost of transport of the raw material as feed for the other industries. Most grape byproducts are currently being wasted in India offering a great opportunity for many new industries.

In wine production, the seeds, skins and stems from the grapes are left at the bottom of the vat. But this leftover gunk isn't just garbage. The scientists at the Pacific Agri-Food Research Centre in Summerland, B.C. Canada, have found a way to turn the grape waste from the wine-manufacturing process into a product of significant value, besides the other products already being produced from this waste.

Using microwave technology scientists have been able to gather oil from the dried grape seed, which can be marketed as a non-food product and used by large cosmetic companies in Europe. The remaining grape waste can then be processed to recover polyphenolics, which are known to be effective in reducing cardiovascular disease and sold as phytochemicals.

8.4b Natural Food Colors and Dyes

Naturally derived colors have been used for centuries. By 1906, 80 synthetic "coal tar colors" were being used in the food industry. In 1995 over 30 natural or nature identical colors were permitted for use in the UK. "Natural" colors have an advantage over synthetic colors in that they are preferred because they are natural.

Since natural pigments such as red beet are powerful anti-oxidants and there is an increase in the trend of sales for such products, one can expect a continuous growth, which has been estimated as 10 to 15% annually at global level which continues to grow with sales said to be \$2.7 B (€ 2.25 bn) in the US alone, according to the Nutrition Business Journal.

In India, there is no systematically compiled data on the market size and cost of individual natural pigment/color products. However, there has been a 40-fold increase in the number of firms that are exporting fruit/vegetable extracts as the natural color concentrates during the last 10 years. There are also in-house research activities in many of these companies to improve the stability of beet color for different types of applications. Natural Food Colors are obtained from any vegetable, animal or mineral that is capable of coloring food, drugs, cosmetics or any part of human body. These natural colors come from variety of sources such as seeds, fruits and vegetables, leaves, algae & insects. According to the application a suitable natural color can be achieved by keeping in mind the factors such as pH, heat, light, storage and the other ingredients.

As per FDA color pigments having a natural origin are exempt from certification. There are 26 colors permitted to be used in food and 28 to be used in cosmetics and pharmaceuticals. A few commonly used natural colors are Annatto (seed), turmeric, beet juice (root), red Cabbage (vegetable), spinach (leaf) etc. Other natural colors used in food industry are mentioned in table 15.

• <u>Annatto Extract</u>	• <u>Curcumin</u>
• <u>Anthocyanins</u>	• <u>Curcumin/CU-Chloro</u>
• <u>Aronia / Redfruit</u>	• <u>Elderberry</u>
• <u>β-Carotene</u>	• <u>Grape</u>
• <u>BeetJuice Colors</u>	• <u>Hibiscus</u>
• <u>Black Currant</u>	• <u>Lutein</u>
• <u>Burnt Sugar</u>	• <u>Mixed Carotenoids</u>
• <u>Canthaxanthin</u>	• <u>Paprika</u>
• <u>Caramel</u>	• <u>Riboflavin</u>
• <u>Carbo Medicinalis</u>	• <u>Spinach</u>
• <u>Carmine</u>	• <u>Stinging Nettle</u>
• <u>Carmine Blue</u>	• <u>Turmeric</u>
• <u>Carminic Acid</u>	• <u>Carrot</u>
• <u>Chlorophyllin</u>	• <u>Chlorophyll</u>

Table 16: List of some natural colors used in food industry

Global Market: In view of increased restrictions on the use of synthetically derived color additives, safe colorants from natural sources are being sought for food and non-food uses. The elevation of the status of natural food colors from mere colorants to health promoting ingredients and rising awareness of their bioactive properties has further increased their demand. The European market contributes 40 per cent of the global natural colors. European Natural and Nature-identical Food Colors Market, reveals the market revenues of \$198 million in 2006 and estimates this to reach \$247 million in 2013.

Many natural colors including curcumin, beta-carotene, lutein and lycopene which have in addition to coloring property pronounced health benefits. For instance, Lycopene has antioxidant properties and is also beneficial for eye-health, can prevent skin aging, cardiovascular disease, cancer, diabetes, osteoporosis and even male infertility. "Apart from these innate benefits, manufacturers have also used technological innovations to enhance product properties such as stability. Recently produced natural colors are relatively more stable in varying conditions of temperature, light and pH.

Indian Potential: The technology for processing of some of the natural food colors has been developed at CFTRI, Mysore using appropriate equipment to get optimal product recovery of right quality. They have the process of extraction of natural colors from turmeric, chilli, annato, kokum, beetroot, safflower and purple grapes. The institute has the necessary expertise to provide technical assistance and guidance for setting up a project and provide technical help to any industrial organization. For this an active marketing and solicitation needs to

be done to convince the new investments in this area to build successful agro industries. Alliances and joint ventures with manufacturers will provide market expansion. In addition, vertical integration with raw material suppliers to make the farmers participate in this industry is possible. The global market for natural dyes is very large (over \$2 Billion/year) and India can be a major player in this growing market.

Anthocyanins: Anthocyanins are a class of flavonoids (Flavonoids are a class of polyphenols comprising more than 4000 identified compounds). The intense absorption of anthocyanins at visible wavelengths of light imparts color to plant tissues including flowers, vegetables, and fruits. As a result, they have a history of use as dyeing agents and food additives. There are 18 common base anthocyanidin (aglycone) species that differ in their patterns of hydroxylation and methylation. In addition, there are well over 300 glycosides and a rapidly expanding list of identified acylated derivatives. Anthocyanins occur in high concentrations in berry fruits and can range from 10 to 600mg/100g fresh weight.

Anthocyanins are allowed as a food additive with E number 163. They are abundant in most fruits and vegetables, which are colored blue to red. The amounts of anthocyanins are rather large (see for example table below). They are relatively more stable than the most other natural colors. The stability of anthocyanins can be increased by structural modifications such as acylation. India has a great potential in catering to the increasing global demand of natural pigment extracts.

Table 17: Potential Anthocyanin sources

Source	Anthocyanin in mg per 100 g
Blackcurrant	190-270
Chokeberry	200-1000
Eggplant	750
Orange	~200
Blackberry	~115
Vaccinium	80-420
Raspberry	10-60
Cherry	350-400
Redcurrant	80-420
Red grape	30-750

Annatto Pigment: Annatto (*Urucum*) is a major food colorant referred as E160b (Codex Alimentarius Committee) with bixin and norbixin as its major components that impart reddish orange tinct to the food. Bixin – a monomethyl ester of a diapocarotenoid – the major coloring component of the pigment, present in aril portions of seeds of *Bixa orellana* L. has importance after the restrictions on the use of many synthetic colorants. Annatto pigment is widely used in dairy industry for coloring Cheese (about 50 percent), and also in fish processing (20 percent), confectionery (10 percent), and other dairy products (20 percent). Being familiar as a lipstick tree it is now projected as a cosmeceutical. Also for dyeing fabrics and leather, and used in traditional health care practices. The advantages of annatto pigment are high tinctorial value and cost effective, solvent/oil/aqueous formulations, stable up to 70°C (bixin) and 100°C (norbixin), with shelf life of 6 months in veg oils at room temperature.

Global Market: World production of annatto seed is about 14,500 metric tons (dry weight) per year. Out of this, 60.2% from Latin America, 27.4% from Africa and 12.4% from Asia and Peru – the major producer (32%). Annatto is considered as a most important pigment-yielding tree. Yield of seeds from four year-old tree can be over 2Tons/ha with 0.9 to 6.9% (average about 2.5%) bixin covering the seeds in a sticky resin (Satyanarayana et al 2002). Globally annatto fetches very good price. For example, seeds ~ US\$ 1,500/ton; 1% bixin powder ~ US\$ 1,000/ton; For a 30% bixin extract ~ US\$ 30,000/ton, Bixin crystal Pure ~ US\$

107,000/ton. One ton of seeds yields approximately 20 kg of bixin.

Indian production of Annatto is only about 500 ton of seeds per year. The organized annatto cultivation is going on in south India. Orissa, A.P, M.P. together accounts 60% of total production. The average Annatto pigment content from seeds in India is 0.36–2.54 %. The commercial baseline for export quality is > 2.5% pigment content in seeds. Much potential lies in plantation of these trees. Annatto plantation needs to be increased with better planting materials and agriculture practices to produce high-pigmented seeds.

Betalaines: There are two main groups of betalaines that are important as food colorings. The most important betacyanin is betanin. Of the betaxanthins, vulgaxanthin-I is the important compound. It contributes about 95% of the yellow coloring obtained from the red beetroot (*Beta vulgaris*). Beet powders, produced by drying beet extract, usually contain 0.4–1.0% pigment expressed as betanin, 80% sugar, 8% ash and 10% protein together with citric acid and ascorbic acid as a preservative. Betalain from red beet and their bioavailability in humans has demonstrated their antioxidant properties. The major betalain of red beets is the 5-O-β-glucoside.

8.5 Bioactive Molecules from Biomass

Plant Growth Promoter (n-Triacontanol): The potential of n-triacontanol, as a plant growth promoter was first recognized in 1977. It has marked effect on the foliar growth at as low levels as 1 to 5 ppm. In fact, commercial plant growth promoting formulations containing n-triacontanol were introduced in India in 70s. Early exploratory studies conducted at CFTRI showed that the waxes from tea waste; rice bran and sugarcane press mud (SCPM) are the important sources. Thus, the product of n-Triacontanol obtained from these waxes, when applied as foliar spray, enhances the productivity of crops like paddy, wheat; commercial crops such as tea, cotton, coffee, mulberry; vegetable crops like cauliflower, cabbage, tomato, brinjal, Ladies finger, chilly; fruit crops like mango, litchi, guava, grapevine, banana, apple; spices and aromatic crops like turmeric, cardamom, black pepper, up to 30% at low application dosage of 1-2mg/acre. Its systematic application in agriculture for better crop yield was made mainly in Asian countries like China, Indonesia, and Japan. In India due to other limitations in agri-inputs, the full potential of this phytostimulant has not been realized.

Indian Potential: The technology developed for n-Triacontanol at CFTRI is a laboratory scale process based on tea wax/rice bran wax/sugarcane pressmud wax. So far 20 commercial manufacturers have taken the process know-how for n-triacontanol and many of them are in the commercial trade over 15 years. Since, the level of application is as low (1-5 ppm), application is economically viable. The formulations can also be supplemented with Zinc in the form of chelated Zinc-EDTA for field

applications. In addition, some multinational companies are also producing and marketing the formulations. In mid eighty's one of the Indian companies (Godrej) had taken the patent on a process for preparation of n-triacontanol formulation from rice bran wax. This is an excellent product and can make a major impact on crop productivity, but it is not clear why ICAR/industry has not pushed further development and marketing of this product at the national level.

Table 18: CFTRI Licensees of Plant growth promoter: containing n-triacontanol

NAME	ADDRESS
West Bengal Pharmaceutical & phytochemical development corporation Ltd.	ILACO House, II floor, 1 & 3 Biplabi Trilakya maharaj Sarani, Calcutta: 700 001
Navbharat Phamaceutical and phytochemical development corporation Ltd.	ILACO house, 2nd floor, 1 & 3 Biplabi, T.M. Sarani, Calcutta :700 001
M/s. Patel K.M.	C/o. Patel Madan Bhadibhai & Co., Main Bazaar, Dhoraji :360 410
Triumph Pharmaceuticals (P) LTD.	No. 1491, III floor, Sreenivasa complex, Shivarampet, Mysore - 570 001
Bhagyanagar Laboratories	S-12, E.E.I.E. Phase II, Balanagar, Hyderabad :500 037
Hyderabad Agro industries	1-81, Pipeline road, Fatehnagar, Hyderabad :500 018
Agro Nutrient Chemicals	Vinjanampadu - 522017, Guntur Dist. A.P.
Sovereign Agro industries	Mutlur P.O., Via Chebrole, Mutlur :522 215
Pragati Glyoxal (PVT) LTD.	Margosa Lodge, 1/1, Krishnaraju road, Chamundipuram, Mysore :570 004
Krishna Biotech (P) LTD.	Sardar Khedi Vikas Kendra, Gundala Road, 38, Sundry Shop, Gondal - 360311, Gujarat State
K.C.P. Sugar & Industries corporation LTD	Ramakrishna Buildings, Post Box No.727, No.183, Anna Salai, Chennai - 600 006
Sakalaspur Organics (P) LTD.	No. 62/1A, Old Tumkur road, Bangalore :560 055

NAME	ADDRESS
Consolidated Agrochemical industries	Koramangala Industrial Layout, Hosur road, Post Box No. 3409, Bangalore :560 034
North Bengal Phytochemical LTD	Paharpur-Post, Dist-Jalpaiguri-735101, West Bengal

Xylitol – a sweetener: Xylitol is a naturally occurring polyol, is finding increased usage as a sweetener in foods industry. It has low caloric value and anticariogenic property. Therefore, it is used in many food industries. It is a natural sweetener with higher sweetness than common polyols. The most significant property of xylitol is that it is an anticariogenic sweetener.

Fermentation of agricultural wastes like corncob hydrolysate and sugarcane bagasse as source of xylose for conversion to xylitol using *Pichia farinos* has been carried out of FTBE. Sugar cane bagasse-xylose has been a suitable substrate for the production of xylitol by microbiological methods. Since the production of xylitol by chemical methods has been found to be expensive due to difficult separation and purification steps, it is worthwhile to explore methods for the effective production of xylitol by enzymatic digestion using microorganisms. No company manufactures Xylitol in India, while China is making it from Corncobs converting a

waste in to Rs. 2000/kg product. India has a great potential in this area if CSIR institutes can develop a comparable technology with China for not only making Xylitol but D-ribose, a new energy stimulant without affecting glycemic index.

Solanesol: Solanesol is prepared from tobacco leaves waste. Solanesol as anti-hypertensive, anti-hyperlipidemic and anti-tumor agent is being made in China. Solanesol, extracted from tobacco leaves by Novo's Super Critical Fluid Extraction (SCFE) process utilizing High Pressure Carbon Dioxide, as the extraction solvent. SCFE process extracts Solanesol at its highest level of concentration and purity. Japanese scientists have used a solanesol derivative, N-solanesyl-N, N1-bis (3,4-dimethoxy benzyl) ethylenediamine for potentiation of anti tumor drugs against multi-drug resistant and sensitive cells. Solanesol is also used as starting material in synthesis of high-value bio-chemicals such as Vitamin-K analogues and Co-enzyme Q10 (Co Q10).

9

MEDICINAL AND AROMATIC PLANTS INDUSTRIES

India is one of the eight important Vavilovian centers of origin of plant diversity encompassing 16 different agro-climatic zones, 10 vegetation zones, 25 biotic provinces and about 426 habitats of specific species. Almost 45,000 plant species (nearly 20% of the global species) occurs in the Indian sub-continent. About 3,500 species are of medicinal values. More than 80 percent of medicinal and aromatic plants (MAP) are collected from 17 million hectares of Indian forests. However, due to over-exploitation some species have become rare such as *Rheum emodi*, *Aconitum deinorrhizum*, and others threatened (*Rauvolfia serpentina*, *Berberis aristata*), or endangered (*Sassurea lappa*, *Dioscorea deltoidea*). Problems arising out of rapid genetic loss of medicinal plants forced the need for international co-operation and co-ordination to undertake programmes for conservation of medicinal plants to ensure that adequate quantities are available for future generations. India uses the plant medicines both for primary health care as well as remedies. India utilizes almost 8000 species in 10,000 herbal drug formulations.

The production, consumption and international trade in medicinal plants, and phytomedicines, are expected to grow in future quite significantly. With this growth in global demand for medicinal plants and a large base of local demand for plant based traditional medicines, the pressure on the existing population of medicinal plants has increased tremendously during the last few decades. Since there is no scientific system of collecting or regenerating these plants, several plants have either been completely lost or have become endangered. Such plants are banned for export but, sometimes, still exported under other names. The trade of medicinal plants is

completely unorganized and often manipulative and exploitative. The industry is engaged in primary processing of plants, manufacturing intermediates, final processing and manufacturing branded drugs, Over the Counter products, food supplements, tonics and herbal cosmetics.

9.1 Cultivation and Processing of Medicinal Plants

Medicinal herbs industry constantly faces the problems of raw material supply. The developed countries are showing rising interest in Indian herbal products as food supplements (Neutraceuticals), cosmetics and intermediates. Several ingredients from Indian plants are being investigated abroad and have found application in many allopathic drugs (Phytopharmaceuticals) manufactured for treatments chronic diseases, such as cancer, AIDS, blood pressure, heart diseases, diabetes, etc.

In order to build the medicinal plants sector to international standards, action in cultivation, post harvest technology, processing, manufacturing, research, patenting and marketing is necessary. It was recognized that more attention needs to be focused on about 45 species and a long-term action plan be implemented for conservation and propagation of all other plants.

Cultivation protocols, post harvest processing technologies, clinical trials, and marketing help are required for the major herbs that can be propagated. Institutional help is also needed in selecting locations for plantations, research in high yielding and short duration varieties, development of nurseries, training and extension

to farmers, introducing and encouraging new technologies like tissue culture, processing, standardization and grading, training to traders and customs officers, infrastructure, finance, provision of fiscal incentives, research and development on various scientific aspect, and branding and marketing of these products.

The intellectual property in herbal products:

The fact is that almost forty five per cent of the herbal patents in USPTO till 1998 were owned by Chinese, another twenty per cent by Japanese and about sixteen per cent by Russians. Chinese leadership in herbal products proves that with the right kind of incentives, even a developing country can achieve global pre-eminence. It is important to note that the first one hundred assignees of these patents were individuals, and not corporations. The notion that R&D by small-scale firms or individual scientists cannot generate globally valuable intellectual property is not true. The traditional Chinese medicine has succeeded in capturing global markets through available trade routes.

Global market: Medicinal plants are both the oldest known source of human and livestock healthcare products and an important component of global biodiversity. However, other health related values are identified under the term herbal and multi-purpose medicinal plants (MMPs).

Natural products (herbal medicines) have an estimated global market value of more than US \$75 billion (WHO, 2001). Even a fraction of this market should be economically important for India. The United States imports hundreds of thousands of tons of many different herbs each year to support its \$ 3 Billion raw herb market. India's total export of herbs and herbal products is less than \$800 Million/year. This global market demand should no longer be ignored by companies, Government and researchers. Herbs and MMPs compare favorably with coffee, oil palm, cocoa, and cotton and their value should no longer be ignored. Furthermore, MMPs do not appear to be affected by market and trade barriers that affect other commodities from developing countries. This presents a significant niche and trade opportunity for India that should be captured and optimized. Rural communities and even tribes have an opportunity to effectively use their indigenous knowledge to become serious players in the global herbal food/medicine market. At present, the use and trade of herbal and medicinal plants is unregulated. With the application of scientific technology, new drugs are being identified from plants long used for traditional healthcare.

- Herbal and medicinal plant extracts are an essential natural source of affordable healthcare for the rural and urban population.
- Management and production of high-demand herbal/medicinal plants and extracts can yield significant economic benefits.
- Herbal and medicinal plants are a significant component of biodiversity.
- The collection, processing and sale of herbal/medicinal plants and their extracts are critical to many economies.
- Herbal and medicinal plants/extracts are primarily collected, traded and used by local communities.
- Herbal and medicinal plants and their extracts are well suited to local management and offer an alternative source of employment.
- Information regarding source and volumes of supply are generally unknown and incompatible with the demand and effective use of these resources.

A sustained supply of authentic and quality medicinal plant material, is critical to feed the fast growing herbal-based industry, and needs a strategic planning for management of plant resources. However, the inadequacy of reliable information about the species-wise consumption and supply of medicinal plants has been the biggest lacuna in prioritization of species for management and designing of the required management interventions (Ved and Goraya, 2008). Prof. Verma helped establish a web portal for Indian Medicinal Plants under the International Medicinal Plants Grower Consortium (www.IMPGC.com), which is available to both growers and traders of the Indian medicinal plants and herbal products.

The total annual demand of botanical raw drugs in the country for the year 2005-06 has been estimated at 3,19,000 tons with trade value of Rs. 1,069 crores. Almost 960 medicinal plant species form source of 1289 botanicals in this trade. Of these 178 species have been identified for priority management action due to their high annual demand to meet needs of domestic herbal industry, rural households and exports. Several recommendations for improving the status of medicinal plant resources in the country have been provided.

In India ninety percent of herbal industry's

requirement of raw material is taken out from the forests, resulting in over exploitation and destruction of its natural habitats. To take pressure off from natural forest some of the medicinal plants have been brought under cultivation to enhance their conservation. Our knowledge about the medicinal and aromatic plants cultivation is very inadequate and need further investigation, which 4 major centers in India must focus.

A recent book on "Demand and Supply of Medicinal Plants in India", (Ved and Goraya, 2008) based on a nation-wide commissioned by the National Medicinal Plants Board on the consumption and sourcing of medicinal plants, seeks to fill this information gap. For those who are interested in growing medicinal plants, a volume by Agarwal and Upadhyaya (2008) on processing and trading of medicinal plants as herbal drugs, is published recently. This book provides a comprehensive literature on agro-techniques, pest and nutrients management, post harvest practices, active ingredient and its uses, marketing pattern etc. that will be useful for growers and industries involved in the use of medicinal and aromatic plants. According to this Survey:

- Estimated Annual Demand of Botanical Raw Drugs* for 2005-06
- Herbal Industry: 1,77,000 tons
- Rural Households: 86,000 tons
- Exports (2004-5): 56,500 tons
- Total 3,19,500 tons

A list of plants identified in this survey is provided at:
<http://nmpb.nic.in/FRLHT/Contents.pdf>

The main recommendations of this study are:

- High priority to be accorded to in-situ conservation as well as resource augmentation of medicinal plant species in high volume trade, being obtained largely from the forests and the state forest departments be supported to undertake these tasks.
- Immediate assessment of the status of wild populations of medicinal plant species in high consumption, with appropriate management interventions for building up populations of such species be developed.
- A system of backward linkage of the raw

material consumed by the herbal manufacturing units to their source of production be developed.

- The existing system of coding of botanicals in foreign trade (HS codes) be critically evaluated to establish clear linkage of traded materials with their plant sources.
- Support studies for reviewing the plant identities in respect of raw drugs obtained from more than one/ controversial plant sources.
- Support the setting up of 1 national and 4-5 regional Repositories of Plant Raw Drugs in Trade to act as reference centers for authentication of raw drugs
- Review and rationalize current schemes for incentive based promotion of commercial cultivation so that the species of conservation concern and facing acute supply shortage could be accorded needed focus.

Indian potential: Improper exploitation of herbal and medicinal plants and lack of meaningful legislation to regulate harvesting, processing and trade is having serious repercussions in India. The demand for plant-based herbal products has grown exponentially during the last two decades (Ved and Goraya, 2008). While this demand might imply a resource sustainability problem, it also offers great opportunity.

Only about 30 percent of population in rural India has access to modern health care and pharmaceuticals. The remaining people rely on traditional medicines, mainly from herbal and MMPs. The degraded lands support a unique biota that offers local residents important land rehabilitation and herbal/medicinal values not only for their own needs, but also for the increasing national and international demands.

Local residents are well aware of the plants' ecological requirements and can play an important role in species selection. Village leadership and institutions can facilitate the establishment of nurseries to produce seeds and seedlings. A number of good practices may be identified that build on the World Health Organization's (WHO) 2003 guidelines on good agricultural and cultivation practices for medicinal plants (WHO 2003) and harvesting guidelines suggested below. A small input in this direction can have a major output for a large

community in dry land states, such as Bihar and Rajasthan.

Present status: The supply of indigenous herbal and medicinal plants depends largely on native plants, which are generally harvested from wild sources. This demand is likely to grow to support almost 10,000 registered herbal industries and a multitude of unregistered cottage-level herbal units to manufacture herbal medical formulations. As a result, wild sources are fast declining due to land degradation, current harvesting practices, overgrazing, and a lack of enforceable management regulations. Neither the socio-economic value nor the potential market for herbal and MMPs is well understood despite of the fact that India is one of the major center of medicinal herbs, and hence this resource is not fully exploited as China has done.

Providing communities with training to manage these resources it can help restore their base. This is especially true for the sustainable harvesting, processing and cultivation of herbal and MMPs, which can help, generate household income, provide local affordable healthcare, and help fill the demands of a rapidly expanding global market for natural health care products.

The agro-technologies for a few medicinal plant crops commonly cultivated in the CIMAP resource centers have been developed and demonstrated in the farmer's fields. This list is too small however, and if combined with those propagated at IHBT and NCR-MP still falls way short of the need outlined in the Medicinal Plants Board Survey stated above. This list needs to grow and include all major species of commercial interest to serve the plantation needs of this industry. **TACSA suggests that all 4 Medicinal Plants Centers join their strength and divide this work to deliver agriculture practice and farming material for all important medicinal herbs that can be propagated at commercial scales, and such technologies be transferred to the private sectors as soon as they are developed.**

These four Medicinal Plants Centers have the resources to build comprehensive agronomic practices of all major medicinal plants within 5 years time and must be given specific mandate to do so, including rescuing the endangered species so that they can be brought under cultivation. This work needs to be done in a time-bound manner giving highest priority by these institutes.

Medicinal Plants Conservation Centre: The Medicinal Plants Conservation Centre (MPCC)

in Pune – is aimed to address conservation and development while revitalizing traditional health practices. In co-operation with local communities, the State Government Forest Department and local non-governmental organizations (NGOs), the Centre uses nurseries and commercial herbal production centers to sell cultivated medicinal plants.

Supported by the United Nations Development Programme (UNDP), the MPCC combines scientific research, community development and education with sustainable income generation and the revitalization of traditional medical practices. This initiative is promoted by the Foundation for Revitalization of Local Health Traditions (FRLHT) in Bangalore and is part of a wider plant conservation network covering five Indian states and over 54 conservation sites. As a result of their efforts around 1500 species of medicinal plants are being conserved across the country, including 76 species highlighted by the UNDP as threatened.

About 26 species threatened by extinction have been identified. The work at this Centre has allowed tribal communities the opportunity to participate in efforts to conserve their botanical heritage while reaping the benefits of income generation and improved access to plants needed for healthcare. Almost 1,600 flowering plants used in various Indian medicinal systems have been identified and logged. Between 200 and 300 species have been identified in each MPCAs by informally trained botanists.

The MPCC is involved in identification, protection, training and promotion concerning medicinal plants in Maharashtra State. Medicinal Plant Conservation Areas (MPCAs) are used to designate sites with important medicinal plant diversity. This involves a number of measures, including:

Thirteen forest areas, each about 200 hectares (2 square kilometers) in size, have been designated MPCAs containing threatened species of value for medicine. Within these area nurseries are used to grow new plants. To date over 50,000 plants of 50 different species have been grown, including six threatened species. Local Management and Protection Committees (LMCs) are formed within each conservation area to manage the nurseries.

As a result of this effort, detailed information now exists on threatened medicinal plants in Maharashtra including conservation

requirements and literature on each species. Nurseries and herbal processing units also provide local employment. Forest officials are learning about the value of medicinal plant resources along with the communities. The supply of high quality planting material for nurseries from the MPCAs constitutes sustainable use. Eventually, cultivation has to meet industrial demand so that all forests become a source for planting material rather than a source for harvesting the plants.

The MPCC project has shown that in only three years time significant results towards conservation of medicinal plants are achieved. Co-ordination between the State Forest Department, local NGOs and rural communities has been crucial to the success of the project. This example needs to be followed in other key states where medicinal plants diversity exists as in North and East.

9.2 Global Standard Set for Wild Medicinal Plant Harvesting

A new standard to promote sustainable management and trade of wild medicinal and aromatic plants was launched in Nuremberg at Biofach, the World Organic Trade Fair in February 20, 2007 (ENS). The standard is needed to ensure that plants used in medicine and cosmetics are not over-exploited.

About 15,000 species, or 21 percent of all medicinal and aromatic plant species are at risk World over, according to the report by the Medicinal Plant Specialist Group of the IUCN's Species Survival Commission that sets forth the new standard. More than 400,000 tons of medicinal and aromatic plants are traded every year, and about 80 percent of these species are harvested from the wild. Almost 70,000 species are involved, many of them in danger of over-exploitation or extinction through over-harvesting and habitat loss. In India, for instance, 319 medicinal plants are listed as threatened by IUCN-the World Conservation Union.

In India flowers of the threatened medicinal tree ashoka, *Saraca asoca* (Roxb) de Wilde, that grows in the state of Karnataka, are used to treat syphilis, the bark for dysentery, and the seeds for urinary diseases.

In the United States, large quantities of American ginseng, *Panax quinquefolius*, and goldenseal, *Hydrastis canadensis*, are collected in the wild. About 90 percent of the ginseng

exported from the United States goes to countries in East Asia.

Following extensive consultation with plant experts and the herbal products industry, the Medicinal Plant Specialist Group has drawn up International Standards for Sustainable Wild Collection of Medicinal and Aromatic Plants, ISSC-MAP.

The German Federal Agency for Nature Conservation was involved in the consultation along with WWF-Germany, and the wildlife trade-monitoring network TRAFFIC, plus industry associations, companies, certifiers and community-based nongovernmental organizations.

Susanne Honnef of TRAFFIC emphasized the need for traders and companies, collectors and consumers to share the responsibility for maintaining populations of medicinal plants, which are valuable natural resources. The ISSC-MAP principles and criteria show how this can be achieved in practice. The standard is based on six principles:

1. Maintaining medicinal and aromatic plant resources in the wild,
2. Preventing negative environmental impacts,
3. Legal compliance,
4. Respecting customary rights,
5. Applying responsible management practices, and
6. Applying responsible business practices.

A California herbal medicine company (Traditional Medicinals), is testing the application of the new standard to the collection of bearberry, a shrub whose leaves are used to treat the kidney, bladder and urinary tract. A German supplier was able to prove the sustainability of their bearberry sources, and they are keen to see how the newly developed ISSC-MAP criteria apply to this trade. Sustainable supplies mean long-term benefits for the local people who rely on the bearberry trade for supplementary income (Josef Brinkman, vice-president of Traditional Medicinals).

Professor Detlev Drenckhahn, president of WWF-Germany, welcomed the launch of this new standard. One of the many challenges in applying a sustainable standard to the collection of wild medicinal and aromatic plants, MAP, is that the dependence of local communities on these resources for health and livelihood security is rarely assessed or recorded.

Little research on harvesting techniques has been done on how to collect wild MAP species sustainably. Maximum quotas for wild collection of medicinal and aromatic plant species are often based on "overly simple and untested assumptions about the relationship between available supply and regeneration" of these plants, according to the Medicinal Plant Specialist Group.

Finally, long and complex source-to-market supply chains make tracing a product back to its source extremely difficult. Still, monitoring is an important part of the new standard. Collection and management practices must be based on adequate identification, inventory, assessment, and monitoring of the target species and collection impacts. The standard provides that the conservation status of target MAP species and populations is applied and regularly reviewed.

The collection area, and neighboring areas affected by collection activities must be protected, especially if threatened, and endangered species and habitats might be affected. The standard suggests that collection activities are carried out in a transparent manner with respect to management planning and implementation, recording and sharing information, and involving stakeholders.

[TACSA learned that a plantation of *Hypericum* (a protected species) grown in Himachal Pradesh had to be destroyed as the grower refused to bribe the Forest Department for its harvesting. A farmer should not need permission to grow any species and harvest it for personal gain. Such practices discourage others to grow unique medicinal plants for business].

Managers may work to support quality, financial, and labor requirements of the market without sacrificing sustainability of the resource, and will prevent and minimize the collection of plants unlikely to be sold. Managers will also provide adequate work-related health, safety, and financial compensation to collectors and other workers, and they will ensure that workers have adequate training, supervision, and experience to comply with the requirements of the new standard.

To view the Medicinal Plant Specialist Group full paper that sets forth the complete standards for harvesting wild medicinal plants, see (http://www.floraweb.de/proxy/floraweb/MAP-pro/Standard_Version1_0.pdf).

A preliminary trial implementation, focusing on community-managed as for medicinal plants in India, was initiated in 2007 by the Foundation for Revitalization of Local Health Traditions (FRLHT) with support from Plantlife International. An initial implementation phase is planned for 2008, focusing on four priority strategies that will provide a broad range of models and practical experience in applying the ISSC-MAP based on:

Certification (by an independent body or industry association), Resource management, Legal adoption and policy, and Voluntary codes of practice are essential.

ISSC-MAP Principles and Criteria:

1: COLLECTION AND CONSERVATION REQUIREMENTS

Principle 1. Maintaining Wild MAP Resources

Wild collection of MAP resources shall be conducted at a scale and rate and in a manner that maintains populations and species over the long term.

- 1.1 Conservation status of target MAP species** The conservation status of target MAP species and populations is assessed and regularly reviewed.
- 1.2 Knowledge-based collection practices** MAP collection and management practices are based on adequate identification, inventory, assessment, and monitoring of the target species and collection impacts.
- 1.3 Collection intensity and species regeneration** The rate (intensity and frequency) of MAP collection does not exceed the target species' ability to regenerate over the long term.

Principle 2. Preventing Negative Environmental Impacts

Negative impacts caused by MAP collection activities on other wild species, the collection area, and neighboring areas shall be prevented.

- 2.1 Sensitive taxa and habitats** Rare, threatened, and endangered species and habitats that are likely to be affected by MAP collection and management are identified and protected.
- 2.2. Habitat (landscape level) management** Management activities supporting wild MAP collection do not adversely affect ecosystem diversity, processes, and functions.

II: LEGAL AND ETHICAL REQUIREMENTS

Principle 3. Complying with Laws, Regulations, and Agreements

MAP collection and management activities shall be carried out under legitimate tenure arrangements, and comply with relevant laws, regulations, and agreements.

3.1 Tenure, management authority, and use rights Collectors and managers have a clear and recognized right and authority to use and manage the target MAP resources.

3.2 Laws, regulations, and administrative requirements Collection and management of MAP resources complies with all international agreements and with national, and local laws, regulations, and administrative requirements, including those related to protected species and areas.

Principle 4. Respecting Customary Rights

Local communities' and indigenous people customary rights to use and manage collection areas and wild collected MAP resources shall be recognized and respected.

4.1 Traditional use, access rights, and cultural heritage Local communities and indigenous people with legal or customary tenure or use rights maintain control, to the extent necessary to protect their rights or resources, over MAP collection operations.

4.2 Benefit sharing Agreements with local communities and indigenous people are based on appropriate and adequate knowledge of MAP resource tenure, management requirements, and resource value.

III: MANAGEMENT AND BUSINESS REQUIREMENTS

Principle 5. Applying Responsible Management Practices

Wild collection of MAP species shall be based on adaptive, practical, participatory, and transparent management practices.

5.1 Species / area management plan

A species / area management plan defines adaptive, practical management processes and good collection practices.

5.2 Inventory, assessment, and monitoring

Management of MAP wild collection is supported by adequate and practical resource inventory, assessment, and monitoring of collection impacts.

5.3 Transparency and participation

MAP collection activities are carried out in a transparent manner with respect to management planning and implementation, recording and sharing information, and involving stakeholders.

5.4 Documentation

Procedures for collecting, managing, and sharing information required for effective collection management are established and carried out.

Principle 6. Applying Responsible Business Practices

Wild collection of wild MAP resources shall be undertaken to support quality, financial, and labor requirements of the market without sacrificing sustainability of the resource.

6.1 Market / buyer specifications

The sustainable collection and handling of MAP resources is managed and planned according to market requirements in order to prevent or minimize the collection of products unlikely to be sold.

6.2 Traceability

Storage and handling of MAP resources is managed to support traceability to collection area. This can best be achieved using a GPS system.

6.3 Financial viability

Mechanisms are encouraged to ensure the financial viability of systems of sustainable wild collection of MAP resources.

6.4 Training and capacity building

Resource managers and collectors have adequate skills (training, supervision, experience) to implement the provisions of the management plan, and to comply with the requirements of this standard.

6.5 Worker safety and compensation

MAP collection management provides adequate work-related health, safety, and financial compensation to collectors and other workers

Challenges for the Indian Herbal Industry:

The recent decision of the government of Canada to keep Indian herbal drugs under watch list and the move by the UK's Medicines & Healthcare Products Regulatory Agency to bring several Indian herbal medicines under suspect list is causing considerable concern amongst the Indian herbal industry. Until the industry begins to follow cGMP practices for processing the herbal materials to reduce microbial load, reduce the heavy metal contamination which is found in wild species, and start processing and packaging these products with high standards (see below) they are not likely to fetch their due share in the international markets. This is an achievable goal

but would require a coordinated effort and cooperation from institutes-industry and the Government (see below).

9.3 Building International-Quality Medicinal Plants Industry in India

The importance of medicinal plants industry is well recognized by all sectors, but the challenge lies in building international quality medicinal plants propagation, processing and marketing systems to capture full value from this sector and passing on some of that value down to the rural level. There are four main components that are essential to achieve this goal.

1. Building and maintaining a comprehensive data base of all Indian medicinal plants accessible to growers, processors, marketing and policy making bodies. Such a database www.impgc.com was initiated primarily to serve Indian Medicinal Plants Growers Consortium, an informal group of people engaged in propagation, processing and marketing of Indian herbs, and further support of this data base with vertical integration of the medicinal plants data would serve many players from scientists to traders as well as the herbal /pharma industries.
2. Developing a mechanism to provide Government certification for "Genetic Fingerprinting" of each species (issued by a private company) and the requirement that such certification is obtained by each party processing and exporting such herbs. India has dedicated institutional facilities to carry out such fingerprinting and establish quality standards, but this activity needs to be done on a commercial scale using the protocols developed by the institution. In addition, a Chemical Finger Printing certificate would be required for each batch of herb being processed and shipped. The standards for this can be provided by the Center of Medicinal Plants (CIMAP), Lucknow and carried out by a private company. Availability of these two documents would increase significantly value to any herbal material being exported out of India. This will also help Indian medicinal plants industry for improving their inputs in to various formulations.

3. Availability of certified seeds and planting material for each species that can be propagated by the farmers is essential. This coupled with genetic Finger Printing data would ensure the quality of material being propagated. Some of the ICAR plant breeding institutes needs to take up medicinal plants seed development projects since much of the crop seeds business has now moved to private companies, which have proved very successful in this venture. There are many species that are close to extinction and have been placed in endangered list by the Government, prohibiting their harvest and export. These species should be propagated and rescued, but despite of many claims by several institutes to be doing so, this task has not been seriously handle any crop and no planting material is available to grow these species in the private sector.

The cultivation practices of many species need to be worked out as has been done by the HRDI, Center for Aromatic Plants, Selaqui, Uttrakhand, NRC-MP, Anand, and CIMAP, Lucknow. The HRDI has developed detailed agriculture practices and booklets about several common herbal and medicinal plants that can grow in the Uttrakhand area. They have also developed a network of distillation units all over the state coordinating with oil-based industries, developed technical training programmes to assist these small-scale industries engaged in this trade. The main objective is to facilitate the development of new crops and products utilizing unique genetic material as well as climate and soil conditions to support development of sustainable profitable production system of aromatic herbs and products. This center also assists farmers in obtaining certificate of quality, but does have limitations in genetic fingerprinting certification at this stage. CMAP has developed farming practices for few common aromatic plants, but they have far more potential to make a difference in this area by assisting in providing chemical fingerprinting service with the help of private companies across the country to cover all medicinal plants.

4. The most important step that Government needs to take, and which no private sector can take in India, is to build two offices, one in Europe and another in

USA for marketing of medicinal plants internationally. These offices linked backward with the Indian Medicinal Plants Growers and Processors would allow to grow this business to the International level and will at least double the trade of medicinal plants within 5 years time. Such marketing efforts can be supported 50:50 by Government and the medicinal plants industry.

To achieve these goals a close interaction among the existing medicinal plants institutes in the country is essential. This activity needs to be in a mission mode to double the export of medicinal plants and natural products with each center taking a part of the responsibility based on their technical expertise. Such a mission can be brought under the overall Secondary Agriculture Improvement (SAI) mission of the Central Government suggested in this report.

TACSA suggests that a Medicinal and Aromatic Plants Certification Office (MAPCO), be established which will issue, for a fee, certificates to private companies about the Genetic and Chemical Finger prints for any species. The actual data could be generated by a private company (fee-based) using protocols provided by CIMAP and CDFD, Hyderabad.

The Indian herbal industry and the Government need to meet these challenges on scientific bases in line with the modern trends of the industry. The Government should help to achieve this goal by organizing its existing institutes as outlined above to facilitate this activity. Cultivation of herbal and MMPs can reduce pressure on wild plants and help stabilize and enrich soil in dry and degraded areas, thus promoting sustainable land management besides providing raw material for high value herbal extracts. Thus a multi-sector community-driven R&D approach to harnessing herbal and MMPs extracts is most advantageous as it follows the holistic process of local people. This activity, if extended to tribal areas can change the lives of millions of people. A list of medicinal plants grown in tribal areas such as in Orissa, is provided at www.secondaryagriculture.org.

A single step i.e. "molecular fingerprinting and chemical fingerprinting" to identify a species for its purity and potency will create a superior product for export in the international market and will help establish a niche for the Indian Medicinal Plants in this fast growing international industry. It is the understanding of TACSA that no other single intervention in this industry will

have such a significant effect. This can be accomplished under the existing infrastructure.

9.4. Value Addition to Medicinal Plants and New Products Development

By combining indigenous knowledge of medicinal plants, application of modern technologies, coupled with some investments from the private sector to identify and develop novel science-based herbal products and using modern management practices one can enhance the value of these commodities which are currently being sold as a raw material for mostly less than Rs 50/kg in Mandies in Amritsar and Dehradun. For rural communities to derive a greater share of the increasing global value of herbal/medicinal plants will require adoption of practices as outlined in the German ISSC-MAP report outlined above coupled with organized marketing.

9.4a Pure Herbs and Herbal Extracts

India shares only about 4% of the global herbal market while China holds 36.5% of this market. Three major problems exist in growing the export of this bioresource.

- 1) Lack of genotypic characterization of pure herbs,**
- 2) Lack of or improper cultivation and processing,**
- 3) Inadequate marketing of Indian herbs at the International level.**

These three issues do not allow small farmer to diversify and cultivate medicinal herbs at a large scale. These problems can be solved by organizing cultivation and processing activities. Institutions should provide necessary inputs to the farmers and the private organizations should develop ability to procure the herbs and process finished product for national markets and export. The outdated Herbal Mandies are not equipped to address these issues which neither have the knowledge nor resources to deliver the desired material for the international markets. The recent decision of the government of Canada to keep Indian herbal drugs under watch list and the move by the UK's Medicines & Healthcare Products Regulatory Agency to bring several Indian herbal medicines under suspect list is causing considerable concern amongst the Indian herbal industry. The Indian herbal industry should meet the challenge on scientific

lines ensuring the genetic purity of plant species used in these formulations and chemical composition of the powder/extract and to ensure that the product is free of heavy metal contamination. Only then the global acceptability of Indian herbs/herb products is likely to increase.

Many small to medium size exporters of herbs and extracts exist in India, but the quality control from this organization is often not up to the international standards and batch-to-batch variation is too high. Alchemy is one of the few companies in India who has in-house sterilization facility. Because of state of art production facility Alchemy has been awarded GMPs certification. They provide raw material like herbal extracts, pure herbs, essential oil and oleoresins for herbal cosmetics and herbal medicine. They manufacture around 450 types of different Herbal products. Because the Indian demand for medicinal plants is also growing there is much need for developing standard practices for growing and processing main herbs at a large scale.

India can grow, process and supply pure certified herbs with specific active ingredients for which there is international demand and such products can be sold as "Food Supplements" in the Western countries including USA. However, neither there is a demand nor it is allowed to sell in the West concoctions of Ayurvedic formulations as "medicines" or "health remedies". Very few companies in India are realizing this fact, and those that have are taking advantage of these markets, such as Himalayan Herbs. This area needs significant institutional help in propagation, harvesting, processing and certification for purity and consistency.

Growth of Herbal Biotech Companies: India has a large number of traditional herbal companies; some of them have initiated advanced R&D-based practices of new formulations with improved processing and packaging. Invited by the Government of Himachal Pradesh, 29 biotech companies including Biosys of the UK and other international companies have come forward to invest in the State of Himachal Pradesh. Himachal Pradesh, which has received grants of Rs 9 crore from the Department of Biotechnology, Government of India is inviting financial and technical bids to assess the financial condition of those companies interested in investing in the State. Companies such as Saak India, Ayush Herbals, Beckons Industries, Sugandhim International and Bioveda have shown interest in investing in the State. The

Himachal Pradesh Government proposes to develop a women biotech village at Fatehpur in Kangra district.

9.4b R&D-Based Phytochemicals and Novel Medicinal Compounds

Medicinal plants forms the foundation of modern allopathic medicines and thousands of active natural molecules have been characterized and chemically synthesized. Central Drug and Research Institute (CDRI) in Lucknow has made some contribution in this direction and has identified few new molecules of potential value. But a large potential remain untapped in light of the diversity of Indian medicinal plants flora and the traditional knowledge that exists about the use of such plants including in the tribal areas. Phytochemistry is the backbone for R&D in this area coupled with modern screening methods of molecular medicine. Phytochemistry as a discipline that is weak in India and there exist a shortage of qualified people across the country. Those they have good skill often find jobs overseas and leave the country.

The wealth for information India has about herbal medicines needs to be tapped systematically and aggressively building state-of the art screening procedures being used at large Pharma companies. This is likely to yield major benefits as a target compound from chronic diseases may have global value in Billions of \$. The investment in this area is also significant and hence private: Government collaboration in this endeavor may prove to be more beneficial. It is recommended that each institute dealing with medicinal plant build a strong phytochemistry group and work in collaboration with others to identify and characterize novel molecules with potential medicinal value. This will only happen if the scientist are given incentives and rewarded from the IP generated from such efforts. A scientist-to-scientist interaction and cooperation needs to be developed rather than based on current institutional framework where only Director-to-Director interactions often take place.

9.4c Functional Foods

The functional foods are those that contain health benefits beyond their usual nutritional value. With consumers taking more control over their own wellness, nutraceuticals may dominate the food and pharmaceutical industries. The nutraceuticals market generally comprise of functional foods and vitamins, minerals and supplements. The ageing population in most part of the World, higher life expectancy, increased

awareness on the impact of nutraceuticals on health promotion and disease prevention will further boost nutraceuticals markets through out the World. China and India are predicted to be the fastest growing markets for nutraceuticals. India with a rich traditional knowledge from Ayurveda, Unani and Siddha system of medicine has sufficient insights into the efficacy of many medicinal plants (e.g. *Acorus calamus*, *Aloe vera*, *Bacopa*, *Monnieri*, *Boswellia serrata*, *Curcuma longa*, *Phyllanthus niruri*) and chemical molecules (eg. Carnitine, Choline, Chondroitin, Coenzyme Q10, Glucosamine, Flavonoids, Taurine, Gamma Linolenic acid and omega 3 fatty acids), and can be a major player in nutraceutical field, if these products are developed of international quality as China has done and become a quality product supplier in this area. Functional foods represent one of the fastest growing segments of the food industry. <http://www.aapsj.org/>. Nutraceutical foods are produced by food companies in collaboration with the distributors of dietary supplements, in order to promote their product by labeling it as healthy.

Global Market: The global market for nutraceuticals is expected to reach \$197 billion by 2010. Stephen L. DeFelice from the Foundation for Innovation in Medicine who coined the word nutraceutical predicts that the nutraceutical may have market of \$500 billion in USA and EEC countries in next decade (DeFelice et al, 1997). The global demand for nutraceuticals will continue to grow and the line of products to include some of the probiotics, soy additives, lycopene, lutein, phytosterols, green tea, glucosamine and chondroitin and coenzyme Q10. Few companies in India have entered in this field, and the market is rapidly growing. The nutraceutical industry dates back to the 1980s and their present global size is in the region of \$125 billion. The leading market for nutraceuticals is the U.S., with a turnover of almost \$29 billion. However, other countries are also starting to promote nutraceuticals. India can play a major role in the growth of this industry.

Indian Potential: Even though the nutraceutical market is still in a nascent stage, it is growing at a very fast and is likely to reach \$270 million in the next three years, excluding vitamin formulations. Today, have realized that the future is for preventive therapy rather than curative therapy. SAMI Labs in India has been manufacturing natural pharmaceuticals and chemical intermediates in Karnataka since 1991. All major trans-national and large Indian pharmaceutical companies have ventured into

nutraceutical products as they see great potential for growth.

Nutraceuticals are a major opportunity for the Indian agro-based Industries. The current nutraceutical market in India is about Rs. 4500 crores (US\$.1.05 B) with an annual growth rate projection of up to 20 percent annually (CFTRI study). The export of nutraceutical from India is less than Rs.750 crores (US\$174M). Among the major players for Nutraceuticals in India are Parrys Nutraceuticals, Dabur, Dumex, British Biologicals, Ranbaxy, Heinz, Novartis, Zydus Cadile, Lupin, Morpen Laboratories, and Himalaya. Some of the nutraceutical products marketed by these companies include Diet drinks with low calories and high fiber, Amino acid drink, energy drinks, life style drink, glucosamine etc. Many of these are just food supplements with no validation for their curative effects. India is relatively a new player in the nutraceuticals market.

There is need for R&D in herbal dietary supplements providing scientific basis of efficacy of these products. The common herbs such as Basil, Rosemary, Oregano, Thyme, Marjoram, mint, curry leaf, sage, beetle leaf etc. having therapeutic value need to be researched for fingerprinting along with the development of novel phyto/nutraceutical extracts and studies for their health benefits. Herbal products, when used as dietary supplements, are not meant for long-term continuous use and many of them may have toxicities, requiring cautions, and precautions in their traditional usage.

The second category of food and tonic herbs can be considered as true dietary supplements due to their long history of safe use, having been well documented over a period of hundreds of years. These herbs are being increasingly used in herbal drinks, extracts and tonic formulations. However, despite their relative safety, their identity and quality have been the most difficult to measure and control. The R&D in this area is a primary concern, particularly in the West.

Many chemicals/biochemicals may contribute to the beneficial effects of tonic herbs. For example, saponins, polysaccharides, flavonoids, and polyphenols are all active components of astragalus root. For this reason, while it is possible to standardize some and provide a kind of guarantee of pharmacologic activities of these herbal extracts, it is challenging to standardize food and tonics using the same techniques. This has created a free-for-all atmosphere in the quality control and manufacturing of herbal

products, resulting in commercial products of widely different quality. A recent attempt by the Government to intervene in this area is a step in right direction.

Carotenoids as Nutraceuticals: Carotenoids have gained importance owing to their beneficial effects to health besides their applications as pigmentation source in aquaculture and poultry and as food and cosmetic colorants. Of the 600 types of carotenoids identified in nature, only few carotenoids like β -carotene, astaxanthin, lycopene, lutein and zeaxanthin are recognized as commercially important. Among the natural sources, carrot, tomato, mango, papaya, palm, green leafy vegetables, marigold are the rich sources for the commercially important carotenoids. Microalgae also form one of the rich sources especially for β -carotene (*Dunaliella*) and astaxanthin (*Haematococcus*). Since the demand for natural carotenoids is growing, the efforts are continuing throughout the world for improving the existing sources for higher productivity.

β -carotene from the alga *Dunaliella salina* was the first high value algal product commercialized. The β -carotene is sold mainly as an oil extract, or as a dried algal powder (Borowitzka & Borowitzka 1989). The β -carotene extracted in vegetable oil can be applied as a food dye and a pro-vitamin additive for human consumption, for fish and poultry feed or in the cosmetics industry as an additive to sun-screen products. β -carotene has been shown to protect against UV-induced skin tumors, UV and carcinogen induced tumors.

The carotenoids market is growing due to interest in healthy diets and the rapidly aging population. World carotenoids Market is expected to reach over US\$ 1 B by 2010. (Carotenoids: A Global Strategic Business Report" published by Global Industry Analysts, Inc.). World astaxanthin market alone is poised to reach US\$219 million by the year 2010, with the United States leading growth. Sales of lutein, and canthaxanthin are highest in Europe. Primary growth is expected to stem from the pharmaceutical end-use market, with potential to reach US\$ 137 million by the year 2010. The food industry, as an end-use application market, also exhibits promising potential, with demand expected to rise by US\$ 46 M.

Astaxanthin is a complex molecule and the synthesis being difficult, results in an expensive product (US\$ 2000-2500/Kg). This requirement has created a market for astaxanthin worth

about 100 million US dollars. Major producers of astaxanthin from microalgae- *Haematococcus pluvialis* are Hawaii-based firms, Cyanotech and Mera pharmaceutical Inc. Recent entry of China in this area is bringing out very competitive products and the prices are dropping.

India has immense potential for carotenoids as it has abundant natural resources, flora and fauna. The carotenoid rich sources can be exploited for commercial production. The vast coastal line is also an asset for exploitation of microalgal cultivation of commercially important strains.

Steviosides, a Non-Nutritive Sweetner: *Stevia rebaudiana* is an herb native to Paraguay. Its leaves contain glycoside compounds (steviosides) that accounts approximately 10% on dry weight basis and are intensely sweet compounds (150 to 300 times sweeter than cane sugar). The leaves have been traditionally used for hundreds of years in Paraguay and Brazil to sweeten local teas, medicines and as a 'sweet treat'. Stevia has been used as a healing herb in South America for hundreds of years. Japan is now the largest consumer of steviosides extracted from Stevia leaves, and is a multimillion-dollar market for stevia, with a 41% market share of the sweetener industry, wherein stevia replaces the chemical sweeteners, aspartame etc, which were banned in the 1970's. These compounds, steviosides, can be extracted and used as alternative sweeteners to sugars, of particular benefit to diabetics and those wishing to reduce sugar intake for health reasons since they act as non-caloric, natural sweetener.

There is an increased interest in various countries including: Brazil, Japan Canada, Georgia, Germany, Russia, Czech Republic, Korea, Mexico, Sweden, Taiwan, Western Australia and USA for Stevia sweetner to be formulated in various forms. The acceptance of this natural product as a sweetener is increasing Worldwide and thus offers a great opportunity for India to produce and compete in the global market of this product.

Global Market: Europe and the United States are the two major markets for herbal products in the world, with a market share of 41 percent and 20 percent respectively. In Japan, Korea, China, Malaysia, Brazil, Israel, Thailand, Indonesia, Taiwan, Vietnam, Mexico, Uruguay, Central America and Germany, stevia is found in all kinds of food products such as baked goods, pickles, teas, drinks, seafood, fruits, vegetables, candies, and even as a table top sweetener. In the U.S. it is available as a table sweetener. In 2002, worldwide demand for Stevia steviosides

exceeded 1,200 Tons. Although Paraguay is plant's birthplace, stevia spread to Asia in the 1970s, where it is now popular, and China now grow 80% of the world's crop.

Indian potential: The market potential for this natural sweetener is completely untapped in India. It is estimated that over 200 million Indians are presently suffering from hyperglycemia and are diabetics. With such a huge percentage of population in need of hypoglycemic food, the new ventures in food industry focused on this sector will have a huge market in the near future. Stevia is been successfully cultivated in the recent years at many areas of Rajasthan, Maharashtra, Kerela, Karnataka and Orissa. The purification technologies and industrial scale production of the final product is limited in India and most of the Stevia grown is exported as a raw material realizing minimum value. The maximum value of such sweeteners is in Table top and medical use products.

Table top sweetener – for tea, coffee etc Soft drinks, cordials, fruit juices Ice-creams, yoghurts, sherbets Cakes, biscuits Pastries, pies, baking Jams, sauces, pickles Jellies, desserts, Chewing gum, Candies, Sea-foods, Diabetic diets Flavor, color and odor enhancers, A source of antioxidants, and as an alcoholic beverage enhancer (aging agent and catalyst).

Medicinal Uses - Toothpaste, mouthwashes – plaque retardant/caries preventer, skin care – eczema and acne control, rapid healing agent, diabetic foods and weight loss food supplements, hypertension and blood pressure control, calcium antagonist and as bactericidal agent

Critical areas for which help from CSIR and ICAR Institutes is required to build Stevia industry in India to it's full potential:

- (i) Identification of adequate varieties that can be established from seeds in different regions of the country.
- (ii) Development of reliable procedures (farm practice) for crop establishment from seed.
- (iii) Development of harvesting and drying procedures essential for efficient mechanization.

- (iv) Development of efficient seed production, distribution and handling procedures.
- (v) Development of appropriate manufacturing procedures that will produce a natural product of reliable quality.
- (vi) Identifying suitable varieties for intercropping should be the priority research area in order to increase the productivity without replacing food crops.
- (vii) There may be opportunities for increasing *S. rebaudiana* biomass and productivity by manipulating density and intercropping by spatial arrangement.

9.5 Aromatic Plants Industries in India

Essential oil industry in India has traditionally been a cottage industry and several thousand such companies exist all across the country. Lately, a number of industrial scale companies have emerged for large-scale production of essential oils, oleoresins and perfumes. The essential oils being produced in India include ajowain oil, cedar wood oil, celery oil, citronella oil, davana oil, eucalyptus oil, geranium oil, and lavender oil. lemon grass oil, mentha oil, palmarosa oil, patchaouli rose oil, sandal wood oil, turpentine oil and vetiver oil. The turpentine oil, and resin from pine is a well established industry having 10,000 – 25000 tons annual production capacity, with pinene and carene the two major components produced from the oil. Alfa-ionone from lemongrass oil for perfumery and beta-ionone for vitamin A synthesis are produced. Introduction of Japanese mint (*Mentha arvensis*), and subsequent improvements enabled India to produce over 500 tons of menthol and made the country a major exporter of natural menthol in the world market. Presently, the areas under mint cultivation are estimated to the almost 40,000 ha mainly in U.P., Punjab, Haryana and to some extent in Bihar and M.P. However, due to export bottleneck, often glut occurs at the production level resulting in shutting down many facilities in Punjab. UNIDO has developed information on the setting up of rural-based small-scale essential oil industries in developing countries.

Essential Oils: The association of essential oils manufactures estimated growth in export value from Rs 50 crore in 1991-92 to Rs 125 crore in 1995-96. India ranks 14th in world export trade,

share being an average 0.6-0.8 % of the total. There is an ample room for penetration into the foreign market especially to the newly developing countries of the middle and for East.

The chemical components of essential oils can be divided into two main categories (Gauniya, 2005). *Mentha aruensis* and mint oil, Cedar wood oil, Clove oil, Eucalyptus oil, Tuberose concentrate, Palmarosa oil, Patchouli oil, Sandalwood oil, Lemongrass oil, Davana oil, Coriander oil, Dill oil, Spearmint oil, Rose oil, *Mentha piperta*, Jasmine concentrate, Jasmine oil, the hydrocarbon monoterpenes, diterpenes and sesquiterpenes, as well as some oxides, phenolics and sulphur and nitrogen-containing material. Common terpenes include limonene, which occurs in most citrus oils, and the antiseptic found in pine and terpene oils. Important sesquiterpenes include chamzulene and farnesene which occur in chamomile oil and which have been widely studied for anti inflammatory and bactericidal properties.

The composition of essential oils is complex. The esters in essential oils include linalyl acetate, as in bergamot and lavender, and geranyl acetate found in sweet marjoram. The characteristic fruity aromas of esters are claimed to have sedative and fungicidal properties. Some aldehydes also have sedative properties, the most common being citralnallal and neral found in lemon scented oils, citral also has antiseptic properties. Several ketones such as jasmine and fenchone found in jasmine and fennel oil, and camphor, (carnone, methone and pine comphone), are effective as medicines for upper respiratory tract infections. However, some ketones are also among the toxic components of essential oils such as found in pennyroyal and buchu.

The alcohol within essential oils is generally nontoxic. Commonly occurring terpene alcohols include citronellal found in rose, lemon and eucalyptus, also geraminal, bornenol, fornesol, menthol, nerol and linalool occurring in rose wood and lavender. Alcohol has antiseptic and antiviral properties and used in aromatherapy. A wide range of oxides also occur in essential oils including ascaridol, bisabolol and bisaleolone oxides and linalool oxide from hyssop. The most important oxide is cineole. It is used medicinally for its expectorant properties.

About 30 % of the fine chemicals used annually in perfumes and flavors come from essential oils. The total consumption of perfumery, pharma and flavorings material in India is about 3800 tons/annum. The estimated production of

perfumery raw material is around 500 Tons/annum valued at Rs 500 crores. According to Trade Development Authority of India the total production of fragrance excluding formulation for captive consumption is about Rs 120 crores/annum. This is a very small fraction of what is consumed in India and hence great potential exist in this area. A number of essential oils form palmarosa, citronella, ginger grass, basil, mint lemongrass, eucalyptus, cedar wood, lavender oil, davana oil, celery seed oil, fennel and other oils have been widely used in a variety of products in India. The essential oils currently being produced in India are oil of citronella, lemongrass, basil, mint, sandalwood, palmarosa, eucalyptus, cedar wood, vetiver and geranium rose oil, lavender, davana oil, oil of khus and ginger grass are produced in small quantities. During the last forty years the importance of developing essential oil bearing plants is increasingly realized. The major essential oil exported are: ginger oil, sandal wood oil, lemon grass oil, jasmine oil, tuberose concrete and other essential oils. The major buyers of Indian essential oil being USSR, USA, France, UK, Netherlands, UAE, Saudi Arabia, Spain, Morocco, Germany, Australia, Pakistan, Korea and Taiwan.

The major export of major essential oil from India is: *Mentha aruensis*, *Mentha piperta*, and mint oil, Cedar wood oil, Clove oil, Eucalyptus oil, Tuberose concentrate, Palmarosa oil, Patchouli oil, Sandalwood oil, Lemongrass oil, Davana oil, Coriander oil, Dill oil, Spearmint oil, Rose oil, Jasmine concentrate, Jasmine oil.

The world trade in essential oil & its products is significant and the oil of major importance are aniseed, citronella, clove, geranium, lemon grass, peppermint oil, patchouli, sandalwood, vetiver, sand wood, mint oil, lemon grass, palmarosa occupies prominent position in the world market. India ranks 26th in import & 14 in respect of export in the world in the trade of essential oils. USA, France, Germany are the top three countries in the world in this business.

Approximately 90 % of the present requirement of essential oil in the country is met by the indigenous production and 10 % from import. Fragrances also find use in toiletries and personal care products. The requirement of essential oils by consumer industries under fragrances, flavor and aroma chemicals are 60%, 20% and 20% respectively (Handa and Kaul, 1995).

9.6 Major Rate-Limiting Issues for Medicinal Plants Export

The lack of awareness and enforcement of quality system in MAPs productions and processing chain is a major critical factor adversely affecting the exports. The final product fails to gain ready acceptability in discerning overseas markets. The problem is that unlike other cash crops, the quality of the medicinal plants is a byproduct of quality enforcement at each step of the chain beginning with right and correct variety for plantation to post harvest processing and packaging. The stakeholders of the medicinal plants processing chain in India, range from illiterate to highly educated entrepreneurs. Thus the quality issue resolution in MAPs become extremely complex. Most of the efforts of quality evaluation is limited to the finished product where the choice left is to accept or reject the final product. The documentation to support any processing activity is non-existent.

There are a number of organizations and institutes, which lay claim on working in the area of medicinal plants in India. CIMAP is the largest and working exclusively in the area of medicinal (and aromatic) plants with multidisciplinary approach and four resource centers (Bangalore, Hyderabad, Pantnagar, Bageshwar) and two resource points (Jorhat, Gandhinagar). CIMAP has dedicated groups dealing with Plant Variety Development, Agronomy and Soil Science, Plant Protection, Organic Systems, Photochemistry, Analytical Chemistry, Genetic Resources and Biotechnology, Knowledge Management Technology and Business Development, Patent Group, Chemical Industrial Technology.

Thus, CIMAP may be in a position to act as a hub for all medicinal plant related activities. Based on the expertise available in the other three institutes, a hub and spoke model can be developed. With audio and video conferencing facilities in place, and proposed knowledge management initiative using a platform like www.IMPGC.com, collaboration, archiving and dissemination will be greatly enhanced among the domain experts of all the four institutes. CIMAP should be able to build necessary platform under its KHETI (Knowledge Hub for Entrepreneurship and Technology Information) initiative. These units must become self-supporting by providing vital services to this sector.

- CIMAP is equipped with state of the art laboratories, ultra modern instrumentation

and expertise in Agriculture, Biotechnology and Chemical Sciences ('ABC' of CIMAP). CIMAP with a team of phytochemists can generate complete chemical fingerprint for each species. This capability can be enhanced by pooling some scientists from the Central Drug Research Institute in Lucknow.

- NRC on MAPs at Anand, Gujarat is the other institute of ICAR that works with agrotechnology focus and they should be able to provide all agronomic practices to the central pool of data.
- A database on Indian Medicinal Plant Growers Consortium (www.IMPGC.com) has been established and with support from Government, this platform can further vertically integrate all medicinal plants data to help scientists, on one hand, and traders on the other hand to increase the sale of the medicinal plants/products from India. Such activities need to be done by private organizations and should become self-sustainable after initial support.

While small scale cultivation has been attempted by many institutes and the private sector there is need to build industrial-scale cultivation of major medicinal plant crops by group of farmers in a cluster approach, following good agricultural practices for quality raw material and for sustainable supply. One needs to focus on two major aspects:

- Quality and Packaging
- Exploration of appropriate markets.

The quality and packaging is of paramount importance in today's market for any product, and medicinal plants are no exceptions. Hence efforts need to be made to process and package products with international standards. For this, import of processing and packaging machineries is essential. These machineries can be had as used equipment at a fraction of the cost and the excise duty on such equipment should be eliminated to spur the growth of this industry.

Proper product knowledge, management skills of international market, suppliers/buyers, pricing, and quality parameters are absolutely essential to grow this industry. Additionally, an international market forecasting system based on historical global production, price fluctuations, area under global cultivation, market scenario (current) of other producing countries, productivity level of the medicinal plant crops, and area under cultivation in India (Singh and

Singh, 2008). A thorough market survey, monitoring and demand assessment mechanism will also be required. This activity must be carried out on regular basis in collaboration with the national and international marketing teams and make that data available on the web, such as IMPGC.com platform for direct access by the medicinal plants growers and traders.

Specific Recommendations to Accelerate Medicinal Plants Industries in India

The following steps need to be taken in order to build the credibility of Indian medicinal plants and meet the global demand of these products:

1. Bring all Medicinal Plants Centers/Institutes under one umbrella with specific focus “to double the production and sales of medicinal plants and herbal products within 5 years.”
2. Establish agronomic practices of all medicinal plants that can be grown in India, including those that are available in Tribal areas. Specific ICAR institutions should take this responsibility.
3. Develop genotypic fingerprint of all major (50 species) plants that are exported from India. The Center for

DNA Fingerprinting can accomplish this task within a two years time.

4. **Develop chemical fingerprint of these species for quality control assessment. CMAP should be able to do this in two years time.**
5. **Create a fee based certification system under a private organization with specific guidelines from the respective institutes.**
6. **Develop two International Offices (one in Europe and another in USA) for the marketing of Indian medicinal plants. These offices' must be able to provide QC data and link suppliers with the buyers to grow this trade. These offices can be supported by a small fee levied on the export of medicinal plants from India.**
7. **Allow import of used processing and packaging equipment as such equipment is not being manufactured in the country and the new equipment is too expensive.**

Only through a coordinated effort of industry and institutes facilitated by the Government can this industry become a global player. This vast potential is awaiting for some one to take a charge and deliver the desired results. All pieces of the puzzle are in place and a full picture needs to be built.

10

ANIMAL PRODUCTS AND BYPRODUCTS

In meat and meat processing sector, poultry is the fastest growing industry in India providing animal protein. The estimated production is 1.5 million tons growing at a rate of 13 per cent from 1995-2003. India exports more than 500,000 MT of meat, which is mostly buffalo meat. Indian buffalo meat has a good demand in international markets due to its lean character and near organic nature. This export has the potential to grow further significantly and presents an opportunity to build organized slaughterhouses. Processing of animal by products, an area that is least developed in India provides significant opportunity for value-addition in this sector. In order to develop necessary infrastructure for processing of meat and meat byproducts for domestic market as well as for export market, the Ministry is providing financial assistance by way of grant-in-aid. During the year 2006-07, it assisted seven projects for processing of meat and meat food products. In light of the increasing demand for meat in the country, the meat industries need to become more organized and fully integrated abattoirs need to be developed. This will add further value to the entire sector.

10.1 The Growth of Meat Export Industry

In India, animals have been kept to produce milk, meat, wool, skins, fertilizer etc. for the rural families and the sale of these products was not relevant. The meat export industry has a much bigger role in the prosperity of the people as seen in several districts that constitute the "catchment" area for procuring livestock. Further development of the meat industry shall serve as a primary source of farm income, rural employment and subsistence. With the strong efforts of the Government, the Dairy Sector has shown promising growth in general, and the Animal Husbandry Sector has shown that it has

the potential to be commercialized to the next level. Unfortunately much of the meat industry is in the unorganized sector which creates unhygienic conditions, pollution, let aside the loss of revenues for the Government and lack of development of secondary animal byproduct industries.

The organized development of the meat industry would be an important source of harvesting value from the culled dairy buffalo and surplus male buffalo calves. In addition, meat processing and its numerous associated industries also provide employment, income and stimulate the local economies. As the consumption of meat is growing due to urbanization and effluence, the meat industry will grow. This sector needs an urgent attention to make full use of this valuable agriculture resource. The meat industry is likely to contribute significantly towards the growth and development of the rural economy by being a source of:

- Subsistence, income and employment in rural areas.
- Food and protein,
- Urban employment,
- An important by-product industry, and
- Provides Investment opportunities.

Why export is important for the growth and development of animal husbandry in India?

- There is little demand for the buffalo meat in the domestic market.
- In the absence of domestic consumption the salvaging of the culled animals itself is a problem.
- In the absence of strategy for gain and utilization of the culled animals and also absence of proper salvaging programs, it poses environmental issues that may surge in the animal diseases due to more

carcasses resulting from the death of the unutilized culled buffalo. This would be in addition to the losses rather than generation of wealth, which would take place if the animals were used for meat purpose.

- The unutilized non-productive animals consume the resources which otherwise could be used for the enhancing the productivity of the potentially productive animals.

To ensure full utilization of the culled animals, it is vital to have the following policies:

- There is a need to have a legal support mechanism to facilitate the gainful utilization of the culled buffalo and surplus male buffalo.
- There is a need to weed out the outdated legislations, which were framed when the status, need and expectations from the animal husbandry were much different, than what they are today.

In the absence of a clear legal framework, it is very difficult for the private sector to make investments without suitable protection and guarantees. This is due to either absence of laws or insufficient/unclear legislations, which subject to arbitrary interpretations.

A good example of a shortsighted regulation is the restriction on slaughtering animals for production of veal in order to maintain or increase the overall productive population. Such action can cause the market to develop a negative attitude towards slaughtering, which may affect their value at a later date. Such regulations have good intentions but are bound to cause long-term damage. This provision alone is a major impediment in utilizing male buffalo calves for lean meat.

- For the control of transmittable animal diseases, such as foot-and-mouth disease, the government must enhance financial support and coverage under such programs. The export markets, keep changing along with prevailing market conditions, transportation costs etc. But having fixed rules in India for this trade and policies (tariff and non-tariff trade barriers), exchange rates etc. significantly affect the ability of a slaughterhouse to deal with this international market. The processing facilities for export have production costs higher than can be absorbed by national market prices in order to meet the international quality and the costs of transportation. The processing of animal byproducts in a end-to-end linkage with such

industries will not only generate additional jobs and provide buffer to this industry, it will help the farmer to get security that such animals can be disposed at a given price as designated slaughter houses.

10.2 Strength, Weakness, Opportunity and Threat (SWOT) Analysis of the Export Slaughter/ Meat Industry

The growth in the meat export was primarily due to the thrust of the exporters. However, recently various departments / agencies of the Government of India have been actively supporting the meat export industry, including the Department of Animal Husbandry, Dairying & Fisheries, Ministry of Commerce & Industry, Ministry of External Affairs, Indian Missions in key countries. India Meat & Livestock Exporters Association (AIMLEA), APEDA and State Animal Husbandry Departments are also supportive of this industry.

The most important virtue of the Indian Buffalo meat as an export product is its competitive price. Therefore, to keep this product internationally competitive, issues affecting the economics of the meat export industry should be addressed by relevant Authorities.

The expectations of the meat Industries are:

- Realization by the Government that meat export industry affects rural development at the very basic level of the poor, and marginal landless farmers.
- Meat export industry does not need any special or out of the way benefits but seeks legitimate application and non denial of existing agriculture improvement schemes.

Efficiency and the economic viability of the industry:

- a. inclusion of additional Districts under Foot and Mouth Disease Control Programme (FMD-CP) in the XIth Five Year Plan.
- b. Need for consistent and uniform Policy across different States for livestock slaughter for export; Male Buffalo Calf Rearing for meat export and leather production.
- c. Restoration of DEPB rates for frozen Buffalo meat effective 2004, (Public Notice No. 47 dated 09.02.2004. Notification no. 68/2007 — CUSTOMS (N.T) dated 16.07.2007) regarding new Duty Drawback rates effective 2007.

- d. Administration of Schemes by Ministry of Food Processing industry and APEDA to be improved (to avoid unjustified denials). This process needs to be made transparent using a web interface with specific time lines to be followed by each party.
- e. Certification charges levied by some States should be reviewed and needs to be more uniform across the country- undue charge have a negative impact on export facilities.

10.3 Existing legislation that is a Constraint for the Slaughter House/Meat Industry

- Exemption from Service Tax on transportation of meat products processed for exports under Section 66 of Service Tax Act, (amendment has been issued to exempt Service Tax on transportation of fruits, vegetables, eggs or milk even for domestic consumption).
- Inclusion of meat as an eligible agriculture product in the Vishesh Krishi and Gram Udyog Yojana (Special Agricultural and Village Industry Scheme)
- Fixation of norms for import of Fuel as per Para 4.9 of Hand Book of Foreign Trade Policy for 2004-2009 (for production of frozen Buffalo meat for export).
- A provision for supply of power at international prices for processing agro based products for export, requiring power intensive processing, may be made.
- Restoration of financial assistance for up-gradation of public/municipal slaughter houses/processing plants engaged in export production in APEDA's Financial Assistance Scheme (FAS) (to 1997-2002 FAS level). These facilities must build links with secondary animal products processing industries to capture more value from the same animal and reduce environmental pollution.
- Restoration of financial assistance for up gradation of private slaughter houses/processing plants for export production in APEDA's Financial

Assistance Scheme (to better than 1997-2002 FAS level).

- Inclusion of Buffalo meat under APEDA's Transport Assistance Scheme for new markets in Africa / CIS where freight cost from India for refrigerated containers is much higher than from competing countries.

Need for consistent and uniform policy across different States for livestock slaughter for export; male buffalo calf rearing for meat export/leather production.

Export of Raw Meat (Chilled/Frozen) Quality Control and Inspection Rules, 1992 defines the criteria of livestock for export. Since slaughter is a State subject, actual processing of meat for exports follows individual State laws, which are at variance with each other. The country needs to have consistent and uniform Slaughter Policy across different States to make this industry competitive.

Male buffalo calf rearing can be productive if there is uniformity in laws. The Department of Animal Husbandry, Dairying & Fisheries, Government of India has realized the importance of Animal Husbandry in the context of the rural development and agricultural growth. Male Buffalo Calf Rearing is critical for supply of good quality hides to the leather industry for domestic/export leather article production.

The increase in health certificate charges and ante-mortem inspection fees by the Government of Maharashtra has increased the cost of production of export-oriented units located in the state of Maharashtra, who have to compete in the global market. It is recommended that the fee charged for issue of health certificate may be reduced from Rs. 15000/- to Rs. 2500/- per certificate which was the fee before the last increase: The fee of Rs. 2500/- is also more than 25 times the existing fee in the State of U.P. and three times the fee in the state of Andhra Pradesh. As regards ante-mortem inspection fee, it is suggested that it may be linked to the cost incurred by the State Government for inspection of animals. This request was made to the Agricultural and processed Food products division of the Export Development Authority (Ministry of Commerce & industry, Government of India) in 2005 but no action has yet been taken.

Export duty of 60% is levied on export of raw hides while on the other hand, under the current import policy and the customs tariff, import of

raw hides is permitted without any restriction and without payment of any custom or excise and there is no export obligation against the duty free import. Obviously this can only benefit the foreign suppliers of hides and domestic manufacturers of leather products for sale in the domestic market, but does not help the meat processing industry. Leather processing industries need to take advantage of this incentive and the slaughter houses need to build close linkages with such industries to get maximum return from this byproduct of the industry.

In the absence of realizing reasonable and proper market prices for raw hides, the export meat industry is at a major competitive disadvantage in comparison to other meat exporting countries where raw hides can be sold at the international market price. The meat export industry is therefore forced to sell high quality raw hides in the local market at abnormally low prices. Approximately 95% of raw hides sold in the country to leather goods manufacturers are processed into products for (domestic) consumption in India. Only about 5% of raw hides sold to the leather goods manufacturers are processed into products, which are then exported. There is no duty on export of leather products and hence significant profit is realized by the leather goods exporters, on account of procuring raw hides within India at distress prices, compared to raw hide prices prevailing internationally.

Exemption from service tax on transportation of meat and meat products for exports: Service Tax was initially imposed on goods transport operators, but was discontinued with effect from 1998. The services provided by goods transport agencies were made taxable vide Finance (2) Act, (2004). Subsequently, the service tax on goods transport by road was made effective from 2005.

The Government of India reconsidered the application of Service Tax on transportation of certain goods vide Notification No. 33/2004 ST in 2004 and granted full exemption from Service Tax to transport of fruits, vegetables, eggs or milk by road. Animal Husbandry Products, including Meat and Meat Products, should be exempted from service tax as meat is becoming a common food product and meat byproducts need to be encouraged rather than being discouraged by adding such taxes.

Exporters covered under VKGUY are entitled for duty credit scrip equivalent to 5% of the FOB value of exports for each licensing year. But

given that export earnings (not originating from units categorized as BOUs or located in SEZs) are now subject to income tax, the net outflow from the Government is only to the tune of 3.5%. During 2005-06, the total exports of buffalo meat and meat products were only Rs.2630 crore. The industry is therefore entitled to Rs. 92 crore (3.5% of the FOB value of exports).

According to industry estimates, 50% of this amount i.e. Rs. 46 crore will directly go back to the farmers in terms of the prices paid to them for their supplies affecting directly rural economy. Another 25% will be ploughed back by the industry i.e. Rs. 23 crore through the activities that will enhance the value of farmer's livestock (Rao and BIRTHAL, 2002). The industry will only therefore be directly getting a net benefit of Rs. 23 crore which is only 0.9% of the FOB value of exports for the year 2005-06.

Supply of power at international prices for processing agro-based products for export: In order to enable Indian agro products exporters all inputs must be available at or below the international prices, the Government has made some provisions in the Exim Policy under the following Schemes:

As per the provisions of the current Exim Policy it is possible to import duty free fuel under Advance Licensing Scheme for use in a Captive Power Plant for production of export products. The DGFT currently fixes quantity of fuel as per Standard Input Output Norms (SION) and where fuel has not been specifically included in SION, duty free imports of fuel are also allowed under Actual User Advance License subject to the condition given in the Exim Policy/Handbook of Procedures as per the percentage rate indicated against each product.

Many industries processing agro-based products for export are not able to avail this Scheme because they do not have adequate resources to install Captive Power Plants for a substantial capacity, as well as it is difficult to operate and maintain Captive Power Plants in remote areas (in the vicinity of raw material availability) where agro-based products are processed for export.

Therefore, it is essential that for production of export products from agricultural/livestock raw material, power should be available at international prices. As the power is obtained by exporters from State Electricity Boards / Public Utility Services, there are substantial duties and taxes included in the power rate. The Government of India has recently correctly stated that we should export products not taxes

and hence there is an urgent need to supply agro-based, power intensive industries, power effectively and at the international prices.

10.4 Financial Assistance Schemes (FAS) for the Meat Export Industry.

Although the exports of meat have grown, with the support of APEDA and the Ministry of Commerce, Financial Assistance Schemes to develop/upgrade the manufacturing infrastructure to keep pace with international standards has been less than adequate. In the IXth plan 1997-2002 one scheme was operational for the private sector "Scheme for Up gradation of Meat Plants" - Assistance to privately owned slaughter house processing plants engaged in export production, to meet the international standards, 25% of the cost subject to a ceiling of Rs25 lakhs per beneficiary.

Since this was totally inadequate, considering the capital expenditures actually being incurred by Units in this industry for up gradation of equipment, APEDA recommended an increase of the ceiling to Rs.50 lakhs for the Xth plan 2002-2007. It may be mentioned that this was also felt grossly inadequate by the industry and we believe the appropriate ceiling should be upwards of Rs. 100 lakhs, Strangely and to the surprise of the industry, not only this inadequate increase was not approved, but even the earlier scheme was just cancelled (February 2003) (whilst FAS for other products covered under APEDAs purview continue).

To meet the increasing demands of international standards, the manufacturing infrastructure requires to be regularly and increasingly updated, the cost of which is usually far higher than any financial assistance, which is provided by APEDA. However, assistance signifies the intent and support of the Government, and in the case of smaller units, the assistance amount becomes meaningful.

Realizing that public sector/municipal slaughter house are also used by smaller meat processors to source carcasses for meat processing, the IXth plan 1997-2002 "Scheme for Up gradation of Meat Plants" included Assistance for Up gradation of Public Sector/Municipal Slaughter Houses, and Processing Plants engaged in export production of meat with international standards (85% of the cost of up gradation). Unfortunately this was also dropped in the Xth plan. The meat export industry urgently in need for reinstating this help in the XIth plan so that necessary up gradation are soon carried out by relevant public slaughter houses to enable

smaller meat processors and to source better quality carcasses for meat processing for exports. In addition, full utilization of animal byproducts will only occur if this sector is being managed with international standards to produce high quality meat and capture value from all animal byproducts. According to the TACSA estimates, a dead animal can be more valuable than the living one if all parts are processed properly and full value is captured.

The industry directly benefits the landless rural poor and marginal farmers, whose primary source of livelihood and existence comes from small livestock holdings. Buffaloes gainfully salvaged by the Industry are those, which have surpassed their period of useful milk production benefitting the farmer. Besides directly benefiting the rural economy, these operations also provide direct and indirect job opportunities and stimulate commerce, including through ancillary and service industries and revenues to the State Governments through various taxes and levies.

A presentation made by Dr. Joginder Singh Berwal, Allansons Ltd. Delhi, provided the following picture of the meat processing and animal byproducts industries in India on behalf of All India Meat & Livestock Exporters Association, (AIMLEA), MUMBAI (nimlea@tndtfl.com). The following basic facts emerged from this discussion.

1. That meat is an agriculture product and it should be recognized as such to buffer the capacity of rural farmer for income under stress conditions.
2. Various tax incentives and subsidies for agro development should be equally applicable to the meat sector.
3. Government needs to take an active role to organize the meat processing industries as it is not only important for the public health and the environment, it is vital for developing secondary industries using this valuable bioresource abundant in India.
4. The need for cold storage houses and inspection of slaughterhouses to maintain sanitary condition is vital for the organized development of this industry which is rapidly growing.

Meat should be included as an eligible commodity in the Vishesh Krishi and Gram Udyog Yojana (Special Agriculture and Village Industry Scheme).

The role of agricultural towards reducing “rural distress” and “enforced migration” is now well recognized. In the Indian context, where the pace of shrinkage of land holdings and paucity of natural resources such as water, outstrips the pace of reduction in the number of people dependent on them, only high value commodities, out of which livestock is the largest element, will become prime drivers of equitable agricultural growth.

Empirical studies of Sharma and Poleman (1993) showed that smallholder livestock agriculture can lead to more equitable growth. Interestingly, the study of Rao and BIRTHAL (2002) shows that marginal and small landholders (<2.0 hectares) comprising 63% of the rural households, accounting for 34% of arable land, carry 67% of the bovines in the country. This livestock in such households not only serves the purpose of augmenting income, employment and food security, but also acts as a storehouse of capital and an insurance against crop shocks while meeting the milk requirement of the country. Besides livestock enterprises being women-oriented, they promote gender equity. The farmers are in a position to fetch a reasonable price for even non-milking buffaloes which serves as seed money for them to rear their existing animals or buy new ones.

Prof. M. S. Swaminathan, Chairman, National Commission on Farmers, stated that: “There is an intimate relationship between livestock and livelihoods in India. In fact, recent studies on incidence on suicides among farmers has shown that in places where crop- livestock integrated production systems are practiced, suicides do not occur... “The ownership of livestock is more egalitarian in comparison to land”.

Livestock products therefore are integral to ensuring the income security of marginal farmers and a growing population of landless labor in the country. It is increasingly felt that the buffalo livestock, promoted both by dairy and export meat sector, is virtually black gold; using discarded/low value resources (like agricultural crop residues) and turning it into high quantity and value added products (milk, meat and byproducts).

The Ministry of Commerce and Industry prepared a special package in Foreign Trade Policy 2004—2009 known as Vishesh Krishi Upaj Yojna (Special Agricultural Produce Scheme). However, in introducing the Yojna / Scheme in 2004 it was unfortunately restricting it to flower, fruit, vegetable products and not covering the livestock sector, and as result a

large section of farmers were deprived of the opportunity to improve their livelihood by participating in the country’s meat export effort.

The Meat Industry apparently raised this issue with authorities concerned for inclusion at least in the Foreign Trade Policy in 2005. However, while the dairy and poultry products were added to the export products in 2005 but the meat industry was again deprived of this provision. It is suggested that the following services be provided to this sector:

- Provision of veterinary services in the rural area.
- On culling, the livestock provides meat and range of raw materials like hides, offal's (for pharmaceutical/pet food industries) and finally rendering of all inedible byproducts for poultry feed. This 100% utilization of all animal parts creates economic benefit, prevents environmental damage and reduces the risk of diseases both to animals and people.
- The meat export industry offers not only backward integration and remunerative prices but has a much bigger role to play in the prosperity of the people in rural area, which constitute the “catchment” area for procuring livestock.

The meat export industry once again followed this issue in 2006 for inclusion of “meat and meat products” in the Vishesh Krishi Upaj Yojana from 2006-07. Despite some assurance though the Scheme was enlarged to include Gram Udyog products and accordingly the Scheme was renamed as Vishesh Krishi and Gram Udyog Yojana (VKGUY) (Special Agriculture and Village Industry Scheme), “meat and meat products” were once again not included. The support provided under VKGUY will, actually translate into ensuring livelihood and income security of small landholders and landless labour who raise such animals.

Given the role being played by livestock, especially in the context of small farmers livestock products need to be treated as a “Krishi Upaj” (Agricultural Produce) of small and marginal farmers. Excluding meat and meat products under the VKGUY is therefore incongruous with the existing policies of the Government.

10.5 Poultry and Fish Feed

With the largest livestock holding, India has the

potential to utilize slaughterhouse byproducts to meet the growing requirement of fish and poultry feeds, enzymes, gelatin and many other valuable byproducts. Processed carefully, a dead animal may be more valuable than live animal in generating byproducts for the international markets. The total availability of offal/bones in the country generated from large slaughterhouses is estimated to be more than 21 lakh tons/annum. Besides other uses, it can also be used as additive for the preparation of animal feeds. Bone charcoal is an excellent filter for various industrial wastes. Activated bone charcoal has a significant value in global markets. Bone meal is used as high quality soil nutrition.

The total requirement of animal feed in India has been estimated at 37 million tons. This includes 24 million tons of cattle feed (which as per the directive of the Department of Animal Husbandry, Government of India cannot have slaughter house waste material). Slaughterhouse waste material has the potential to partly replace 13 million tons of animals feed material as inputs to feeds for the poultry, fish and pets. Dog biscuits are made from animal waste.

Presently in India, livestock feed production is more of cereal based and less of animal by-product based. This results in livestock, especially poultry, pig and fish competing with humans for grains and cereals, which can easily be replaced with slaughterhouse waste. The fish skin, bones and other marine animal waste can be processed as feed for fish industry as well as other animal feeds (excluding dairy animals). Fish and poultry are highly efficient in converting animal waste in to high value meat, the demand for which is increasing rapidly in India.

Slaughterhouse waste is first converted into intermediate products like Meat Bone Meal (MBM), Dicalcium phosphate (DCP) & bicalphos (BCP) which are essentially feed supplements. They are then mixed with various crop ingredients to make a complete feed for animals. Meat Bone Meal is a protein and phosphorous supplement for animal feed manufacturers. It is used up to 5% of total feed. DCP and BCP are essentially phosphorous supplements for animal feed and are used to the extent of 1% of total feed. Currently total production of MBM in India is around 55,200 tons/year and total estimated demand is 77,500 tons/year, making India an importer for this product while India should be a net exporter because of the number of animals

available for slaughtering. So the gap between production and supply of MBM is estimated to around 22,300 tones/year. Major manufacturers of MBM in India are Standard Agro Vet (P) Ltd., Allansons Ltd., Hind Agro Ltd., Al Kabeer, Hyderabad.

Similarly the total production of DCP in India is a around 27,600 tons/year and total demand is 34,800 tons/year. Thus the gap between production and demand of DCP is approximately 7,200 tons/year. Some of the manufacturers of DCP in India are Hind Nihon Ind. Ltd., Muradnagar, Punjab Bone Meal, Jallundar, Kerala Chemical & Proteins Ltd., Cochin & Shaw Wallance Ltd, Jabalpur.

The processes involved in this industry are basically pre breaking, cooking, sterilization, fat removal, drying and finally milling and packaging. Efficient utilization of energy (particularly solar energy) can make India as a major feed supplier to meet its own demands and export to Middle East. Currently a vast gap exists between demand and supply of intermediate products like MBM, DCP, BCP etc. which is being met by use of substitutes like Soya meal, Meat meal and Fishmeal. There is a vast potential for setting up slaughterhouse waste processing plants for manufacture of MBM/BCP and feed supplements.

A report on "Utilization of Slaughterhouse Waste Material for the Preparation of Animal Feed" has been prepared in India and highlights all the above issues and is an ideal guide to entrepreneurs & industries who are interested in setting up plants for utilization of slaughterhouse waste. This report deals with low-tech products yielding raw material for other industries, such as microbial media. These industries while asking for a variety of subsidies for making them competitive in the Buffalo meat market export (see below), they are not fully utilizing the byproducts from their own facilities to capture full value from this bioresource. Many new industries can be, and need to be, generated using such byproducts from the slaughterhouses.

Poultry Feed From Animal Byproducts in USA (A case of value-capture): Animal derived protein meals such as meat and bone meal (MBM), meat meal (MM), poultry meal (PM), hydrolyzed feather meal (HFM) and to a lesser extent blood meal (BM) and fish meal (FM) have all contributed as important feedstuffs for poultry nutrition. The production and processing of livestock and poultry for food

production in North America annually produces nearly **50 billion pounds** (22.7 Million Tons) of raw animal tissues that are not subsequently utilized as food (According to Dr. Gary G. Pearl, Fats and Proteins Research Foundation, Inc. USA). These raw materials have been used as valuable feed ingredient resources following their further processing by the rendering industry. The rendering process is a safe proven process, which evaporates water, extracts fat and results in approximately a 25% fat and a 25% protein yield from the raw material. The process completely converts muscle and other tissues into protein rich granular type substrates and fats with specific nutritional components that has absolutely no resemblance to the original raw material. The resultant ingredients have been characterized into their nutritional contributions for fulfilling the specific requirements of nutrient demands for each animal species.

Traditionally the composite poultry industry has utilized approximately 37% of the total animal protein annual production. Thus the poultry industry has been a very important market for rendered animal proteins. Synergistically the rendering industry has for over 100 years provided services and products that have been valuable economic, biosecurity and environmental resources for the animal industries. This synergism has allowed for the sustainable and the most efficient, safest meat producing system in the world. To increase poultry productivity at economical price animal byproducts derived meal can play an important role in India. For more food processing by-products for animal feed and pet foods, see the following sites:

<http://www.bae.ncsu.edu/programs/extension/publicat/wgwm/cd37.html>, <http://www.frr-healthypet.com/naturalingredients.html>

The main problem in India remains that much of this sector is unorganized and too few large-scale slaughterhouse exist to make use of all byproducts. India needs to take an urgent step to organize this industry to ensure meat safety and full utilization of animal byproducts. With added advantage of environmental benefits that will come out of this endeavor, it will make such industries acceptable for location in proximity of any development, which currently is not the case. In a visit to Punjab by TACSA members, the Honorable Chief Minister specifically requested help in this area as mountain of carcasses are piling up near Chandigarh creating environmental problem without any proper disposal or use.

10.6 Other Animal Byproducts

High Value Proteins/Enzymes from Animals:

The Indian slaughterhouse byproduct industries have only focused on bulk materials for feed industry, however, much larger potential exists for processing fresh animal tissue for valuable proteins, such as aprotinin from lungs, alkaline phosphatase from intestine, calmodulin and deoxycholate from brain myelin from nerve tissue and DNase, RNase from pancreas, hyaluronic acid, from intestinal mucosa, and Bovine serum albumin and hemoglobin from blood. These products can sell from Rs 10,000 to Rs 5 lakh per kg. This allows significant returns from processing of various animal tissues but requires knowledge to prepare, access to markets, and ability to sustain that activity for reliable production for the international R&D markets. These products have global markets and most of them are currently imported in India for analytical use. China is quickly becoming a major player in this area as well. Such Industries are non-existent in India and require close cooperation with scientists to develop these products. Most of such products are currently imported.

Animal Rendering: Unprocessed animal byproducts and mortalities contain large numbers of microorganisms, including pathogenic bacteria and viruses. Unless properly processed in a timely manner, these materials provide an excellent environment for disease causing organisms to grow and potentially threaten animal health, human health and the environment. If allowed to accumulate and decompose without restraint as is happening in some places in Punjab, these tissues would become a substantial biohazard, promoting disease, attracting and harboring rodents, insects, scavengers and other recognized disease vectors and attracting predatory animals into densely populated areas. Without the processing services of renderers, massive problems of disposal from farms/feedlots, slaughter facilities, food processors, restaurants and institutions would result, contributing to serious challenges for disease transmission, disease prevention and control and environmental and public health.

The value of the rendering process as a mechanism to control risks from microbial pathogens as well as other hazards was validated in a United Kingdom Department of Health study (2001). Risks of human exposure to biological hazards were found to be negligible when animal mortalities and byproducts were processed by rendering, incineration or funeral

pyre. However, incineration and pyres cause moderate to high exposure to chemical hazards associated with burning. Only materials that had been rendered had negligible biological and chemical hazards. The agent causing BSE was the only exception and it was found to pose a negligible risk to humans when the solid products from rendering were subsequently incinerated.

Renderers convert dead animals and animal byproducts into ingredients for a wide range of industrial and consumer goods, such as animal feed, soaps, candles, pharmaceuticals, and personal care products. U.S. regulatory actions to bolster safeguards against bovine spongiform encephalopathy (BSE or mad cow disease) could affect significant changes in renderers' business practices, the value of their products, and, consequently, the balance sheets of animal

producers and processors. For more detail, see: (<http://www.nationalaglawcenter.org/assets/crs/RS21771.pdf>)

The animal rendering process in India is not well developed and the Visit by TACSA members to Punjab found that mountains of carcasses are piled up as waste creating significant environmental hazard. The honorable Chief Minister of Punjab requested specific help in this area. It is a necessity that such industries be encouraged to develop as they utilize animal waste in valuable products such as bone meal, bone charcoal, and fertilizer materials from such wastes. With millions of animals die each year through natural cause and the waste from slaughterhouses, if processed properly it can create large industries for much needed bioresource as agriculture inputs.

11

ALTERNATE BIORESOURCES AND TECHNOLOGIES

There are a host of secondary agriculture industries that add significant value to total agriculture economy in the West. These include vermiculture, biocomposting, honey bee farming, silviculture, algal farms, let aside fermentation, bioprocessing and high value bio products derived from animals and plants as well as from microorganisms. The honey bee industry alone adds \$15 billion a year in value to the U.S. food supply as almost ninety crops depend for pollination services of honeybees, in addition to the value of honey and bee wax in the food chain. This industry is not well developed in India. Some progress has been made in vermicomposting and many rural organizations are developing to produce this valuable input for agriculture. A holistic view is required to develop agroindustries and build rural economy from ground up. No single crop or technology will be sufficient and hence a broad activity fueled by institutional innovations and entrepreneurial spirit would invigorate the agro industries sector.

Fermentation industry is large, particularly in Europe and Japan, producing a variety of compounds besides beer and alcohol. This industry has a significant potential in India but unfortunately it has not been fully developed beyond alcohol fermentation using yeast. Some activity has started in making enzymes for industrial use (Helmut 1998) such as paper and leather industries, but that too is very primitive and no industrial scale recombinant enzymes are currently made in India, offering significant opportunity. Again in this respect help from CSIR/DBT and ICAR institutes is needed to identify the right gene, clone it and transfer the technology to respective industry for producing these enzymes by fermentation technologies which already exist. Without this help the

industry will have no choice but to continue using out-dated technologies or go out to get hold of such needed technologies.

11.1 Enzymes and Chemicals

Industrial Enzymes: Enzymes offer a great potential for many applications for the improvement of not only foods but also catalyzing many other industrial chemicals production. Out of the nearly 7000 enzymes discovered, only about 100 or so are useful industrially. Some of the major industrial uses of enzymes include leather manufacture, textile, food, feed and pharmaceutical. They influence not only taste but also the texture, appearance, shelf life, nutritional value, and process tolerance of food products. Carbohydrases, enzymes that act on carbohydrates, play a very critical role in the preparation of low glycemic index foods targeted for diabetics and diet conscious consumers. Amylases are used in the bakery industry. Proteases are used extensively in the beer industry. Lipases are placed only after proteases and carbohydrases in world enzyme market and share about 5% of the enzyme market (Gandhi 1997). Compared to enormous potential, the use of lipases in food industry at present is almost negligible. Hydrolysis of fats and oils is still being carried out by the conventional emulsion system and not with the use of lipases. But the technology is advancing to provide enzymes as substitutes of the conventional chemical process. Lipases have a role to play in the detergent industry. Phytases are used extensively in animal feed industry for improving the bioavailability of micronutrients like iron, zinc and phosphorus. Lipoxygenases find application in the flavor industry. Many of the functional foods are manufactured with the use

of enzymes. The use of enzymes in food processing industries in India is currently very limited but expected to increase in next few years. This demand would be unique, as all such enzymes need to come from fungus or plant source because majority of population is vegetarian.

The worldwide sale of industrial enzymes is expected to reach to US \$ 3.0 billion by the end of this decade. Out of these 25% is for use in the food industry. Enzymes are conceived as natural and environmentally friendly as they are effective catalysts under physiological conditions. With biotechnological improvements of strains, costs of enzymes have reduced dramatically. It is estimated that 20% of this global sale of industrial enzyme comes from cellulases, hemicellulases and pectinases. These enzymes are used mainly by food, pulp and paper and textile industries. Xylanases, xylosidases, ligninases, glucose isomerases and cellulases are enzymes that play an important role in bioconversion of lignocellulosic biomass into value added products such as sweeteners, fuels etc.

In 2006–2007, the total bioindustrial enzymes sector made an impressive turnover of Rs. 3950M, with a growth rate of 5.3 %. India imports about 70 per cent of the total enzyme consumption. At the same time, India is exporting some Industrial enzymes to Asian, Latin American and European countries. The food market today shows a clear trend towards more 'green products' and this has obviously favored the use of enzymes. No enzymes are used in India at present for food processing.

By far, the largest use of enzymes is the amylases in baking industry. The use of phytases is growing in the animal feed industry but the availability of active sources of phytases is still a problem in India. Developing processes for the production, down stream processing of food enzymes to obtain enzyme concentrate and to test their applicability in food processing are identified as gaps in technologies existing today (Whitaker et al., 2003).

The production of functional ingredients like oligosaccharides from pectin, inulin, chitin and pullulan and their incorporation into foods would lead to value added products. Many of the oligosaccharides, products of enzymatic reactions with carbohydrates, form soluble fiber, necessary for good digestion may help avoiding colon cancer. These oligosaccharides are also digestible by the gut microflora and are considered to be prebiotic. The removal of phytic

acid from plant foods would improve the nutritional quality. In addition, value addition to by-products like oilseed cakes would be ensured with edible grade flours having high protein content would become feasible. This would offer possibilities of creating new markets for these foods in the country. These foods can be designed for specific target populations like diabetic, geriatric, pediatric and athletes.

In a bakery operation, enzymes are viewed as valuable assets that make the job of turning out consistent bakery products a little easier. Historically, malt extracts - which are rich in native barley enzymes - were added to doughs to get the benefit of those enzyme activities. Today, it is common to supplement native flour enzymes with exogenous enzymes produced by microorganisms, particularly amylases, proteases and xylanases. Some of the benefits of enzymes in bakery products are consistently improved machinability, higher loaf volume, smoother crumb characteristics and longer shelf life.

Most of the industrial enzymes are produced from microbial sources. While, the enzyme of interest is one of the major proteins produced under the optimized conditions, for which recombinant enzymes provide the best solution. Enzyme mobilization technologies and developing recombinant enzymes for industrial use offers great potential for India.

Indian potential: India with its large biodiversity has a great potential for the discovery of new microorganisms that are capable of producing novel enzymes or enzymes with novel characteristics. The use of enzymes in food processing in India is very limited. One of the main constraints in using enzymes for food processing in India is the cost effectiveness. Investigations have been carried out on the production of the enzymes in India. Most of them have been on the lab scale mainly in flasks. Very few attempts have been made to develop processes for the production of food enzymes on a large scale and downstream processing. There is a need for developing processes that can deliver robust enzymes for the food processing industries as being done in the West.

India has begun producing some of the industrial enzymes for the leather and paper industries but the list of enzymes to be made is very long and, in addition to fungal and bacterial enzymes recombinant enzymes hold great potential. Recombinant enzymes are infact being made for a variety of uses while there is no such company in India yet. Biocon is making theraputic protein

using recombinant technology. The major industrial enzymes are:

- Thermostable Alpha-Amylases for the sweeteners industry,
- Thermostable Liquefying Enzyme, Acid-stable, Low Calcium
- High-strength, Low Temperature Liquefying Enzyme.
- Glucoamylases, Hydrolysis of soluble starch to glucose,
- Saccharifying Enzyme,
- Glucoamylases and Pullulanases, High glucose syrup,
- Saccharifying + Debranching Enzymes,
- Single-use Granular Immobilized Isomerizing Enzyme,
- Single-use Granular Immobilized, Isomerizing Enzyme,
- Isomalto-oligosaccharide, Producing

- Enzyme Filtration Enzymes,
- Lysophospholipase for Wheat Syrup Filtration Debranching Enzymes,
- Barley Beta-Amylases,
- Diastatic Beta-Amylase, Fungal Alpha-Amylase
- Cellulases and Xylanase
- Whole grain feedstock and biomass processing,
- Starch Separation/Viscosity Reducing Enzyme,
- Xylanase for Viscosity Reduction,
- Developmental Enzyme for Starch Separation/Viscosity Reduction
- Beta glucanase 750 L
- Thermostable Beta Glucanase/Xylanase for Viscosity Reduction

Table 19: List of Specific Industrial Enzymes and Their Uses

Name	Application	Origin
Alkaline Protease *	Animal Feed Cleaning & Wastewater Food & Beverage Other	<i>Bacillus licheniformis</i>
Alpha Galactosidase	Animal Feed Dietary Supplements Food & Beverage Other	<i>Aspergillus niger</i>
Amyloglucosidase (Glucoamylase)	*Animal Feed Baking Dietary Supplements Food & Beverage Other	<i>Aspergillus niger</i>
Aquaculture Blend	Animal Feed Microbial Products	<i>Various Strains</i>
Bacillus Blend Liquid Conc.	Animal Feed Cleaning & Wastewater Microbial Products Other	<i>Bacillus subtilis and Bacillus licheniformis</i>
Bacillus Blend Liquid RTU	Animal Feed Cleaning & Wastewater Microbial Products, Other	<i>Bacillus subtilis and Bacillus licheniformis</i>
Bacillus Blend with Enzymes Liquid RTU	Animal Feed Cleaning & Wastewater Microbial Products, Other	<i>Bacillus subtilis and Bacillus licheniformis</i>
Bacterial Alpha Amylase *	Animal Feed Baking Cleaning & Wastewater Food & Beverage, Other	<i>Bacillus subtilis</i>
Bacterial Amylase Fermentation Product	Animal Feed Cleaning & Wastewater Microbial Products, Other	<i>Bacillus subtilis</i>
Beta Glucanase *	Animal Feed Baking	<i>Trichoderma longibrachiatum</i>

	Dietary Supplements Food & Beverage, Other	
<i>Bifidobacterium longum</i>	Animal Feed Dietary Supplements Other	<i>Bifidobacterium longum</i>
Bromelain	Animal Feed Baking Dietary Supplements Food & Beverage, Other	<i>Ananas comosus</i>
Calfzyme Plus	Animal Feed Other	<i>Enzyme / Bacteria Blend</i>
Cellulase *	Animal Feed Baking Cleaning & Wastewater Dietary Supplements Food & Beverage, Other	<i>Trichoderma longibrachiatum</i>
Cellulase-AN	Animal Feed Cleaning & Wastewater Dietary Supplements Food & Beverage, Other	<i>Aspergillus niger</i>
Fungal Acid Protease	Animal Feed Dietary Supplements Food & Beverage	<i>Aspergillus oryzae</i>
Fungal Alpha Amylase *	Animal Feed Baking Dietary Supplements Food & Beverage, Other	<i>Aspergillus oryzae</i>
Fungal Amylase Fermentation Product	Animal Feed Cleaning & Wastewater Microbial Products, Other	<i>Aspergillus oryzae</i>
Fungal Lactase	Animal Feed Dietary Supplements Food & Beverage, Other	<i>Aspergillus oryzae</i>
Fungal Protease	Animal Feed Baking Dietary Supplements Food & Beverage Other	<i>Aspergillus oryzae</i>
Hemicellulase *	Animal Feed Baking Dietary Supplements Food & Beverage , Other	<i>Aspergillus niger</i>
<i>Lactococcus casei</i>	Animal Feed Dietary Supplements	<i>Lactobacillus casei</i>
<i>Lactobacillus acidophilus</i>	Animal Feed Dietary Supplements Other	<i>Lactobacillus acidophilus</i>
Neutral Protease *	Animal Feed Baking Food & Beverage, Other	<i>Bacillus subtilis</i>
Papain	Animal Feed Baking Dietary Supplements Food & Beverage, Other	<i>Carica Papaya</i>
Pectinase *	Animal Feed Dietary Supplements Food & Beverage, Other	<i>Aspergillus niger</i>
Phytase	Animal Feed	<i>Aspergillus niger</i>

	Other	
Poltryase Plus	Animal Feed Other	<i>Enzyme / Bacteria Blend</i>
Xylanase	Animal Feed Baking Dietary Supplements Food & Beverage, Other	<i>Trichoderma longibrachiatum</i>

Amyloglucosydases and pectinase are currently produced by Bio-con India by solid-state fermentation. Very high indigenous demand exists for these enzymes and the returns on investment are about 24-26%.

Pulp and Paper Processing Enzymes: The demand for high quality paper in India is exploding and different kinds of papers are needed to meet diverse needs. These are: Printing and Writing Paper, News Print, Tissue Paper, Packaging and Industrial Paper, Kraft Paper, Paper Bags, Paper Board and Corrugated containers. Having a shortage of wood-derived pulp for paper industries, alternative sources of pulp material is needed, including recycled material. In most of the pulp industry, lignin and xylan contents are a major problem and removal of lignin is expensive both for the environment and the cost of processing. Delignifying enzymes are much needed and alternate bioresource has to be found, including straw, bagasse, alternate annual crops are much needed to support this growing demand of paper industry. Enzyme application improves pulp fibrillation and water retention, reduction of beating times in virgin pulps, restoration of bonding and increased freeness in recycled fibers, and selective removal of lignin and xylan from dissolving pulps.

Xylanases are useful in dissolving pulps, yielding cellulose for rayon production, and biobleaching of wood pulps. Pulpzyme HA, introduced by Novo Nordisk A/S, was the first commercially available xylanase for use in biobleaching of wood pulps. It was extracted from a strain of *Trichoderma reesei* and was used in the first bleaching stage to reduce the dosage of active chlorine. Several multinational biotech companies are marketing various xylanase preparations, such as Irgazyme (Genencor International), Cartazyme (Sandoz), Ecopulp (Alko), and VAI xylanase (Voest Alpine). Enzymatic pre-bleaching has been successfully demonstrated on mill scale wherein a pulp with 88% 35 tons of Albazyme 10 was used to treat and produce 35,000 tons of fully bleached pulp from hard wood as well as soft wood. For this alkali-stable and heat-stable

xylanase are needed for large-scale pulp biotechnology.

Besides xylanases, mannanases as well as side-chain-cleaving enzymes, such as alpha-arabinofuranosidase, have also been evaluated depending upon individual raw materials used under different situations for paper manufacture. India is producing natural xylanases but they are not well suited for the Industry and require change in temperature and pH for optimum activity, so new recombinant enzymes are needed for this industry.

Proteases: Proteases are specific for protein; they hydrolyze a variety of protein bonds from different sources - both animal and vegetable. Proteases, in particular, are becoming valuable tools in the conversion of protein byproducts into high-value functional ingredients. As the selection of proteases from various plant, animal and microbial sources increases, the opportunities for combining enzymes to create new food ingredients multiply.

Using specialized mammalian protease called chymosin, a limited hydrolysis of milk protein is achievable for the specific purpose of forming a protein curd for cheesemaking. Other types of proteases are able to convert solid proteins from meat, fish or legumes into liquid slurries or protein hydrolysates, as in the production of savory flavors.

Although a wide variety of bacterial and fungal proteases are now available, papain still enjoys a certain popularity in several industries, including brewing, where it has been used for chill-proofing beer via its ability to degrade the protein component of haze.

Papain is imported in US and Europe from regions of the world where a special variety of papaya fruit is grown for its protease enzyme content. Valley Research, Inc., an enzyme company based in USA, finally eliminated two limitations of papain. "Papain has an odor reminiscent of old gym socks,". After two years of working with papain growers in India, they developed an improved enzyme-recovery

process that not only results in an enzyme product with less odor, but eliminates the use of metabisulfite as a preservative, which is toxic.

Lipases: Lipases are placed only after proteases and carbohydrases in world enzyme market and share about 5% of the enzyme market. Lipases can be produced on a large scale by fermentation but their use was mainly in oleo-chemistry and dairy based industry. Recently lipases have made a place in manufacture of pharmaceuticals and pesticides, single cell protein production, and in waste management. Lipases are being used in the food industry and used in the preparation of a variety of products including fruit juices, baked food, vegetable fermentation and dairy enrichment. They are used in the leather industry and aerobic waste. The lipid digesting preparation is employed in sewage disposal plants in USA under the trade name lipase M-Y (Meito Sanyo Co., Nagoya Japan). The growing interest in Lipases is reflected by publication of an average of 1000 research paper per year on different aspects of enzymes.

Indian Potential: The potential application of enzymes in the food industry includes biotransformation of fats and oils, synthesis of specific triglycerides, emulsifiers, oligosaccharides, and peptides and flavor production. Enzymes are usually used as processing aid and not found in actives form in the final product. Since enzymes are inactivated by pasteurization or heating processes.

Lipases in the food industry

Lipase produced by *Candida rugosa* is one of the most industrially used enzymes. Poly glycerol and carbohydrate fatty acids esters are emulsifiers in variety of food formulations (low fat spreads, ice creams, mayonnaise).

Lipases in detergents

Biological detergent making is a fast-growing technology. Removal of oil/fatty deposits by lipase is attractive owing to its suitability under washing conditions. To be suitable additive in detergents, lipases should be thermophilic and alkalophilic and capable of functioning in the presence of various components of washing powder formulations. Lipases find use as lipid stain digesters.

Lipases in environmental management

Lipases have been used for degradation of wastewater contaminants such as olive oil from oil mills. The treatment process

consists of the cultivation of lipase-producing microbial strains in the effluents.

Lipases in the cosmetics and perfume industry

The use of lipase in cosmetics and perfume industry is mainly due to its activity in surfactants and in aroma production, which are the main ingredients in cosmetics and perfumes. Monoacylglycerols and diacylglycerols, prepared by lipase-catalysed esterification of glycerol, are useful as surfactants in cosmetics.

Lipases in biomedical applications

Lipases have emerged as important biocatalysts in biomedical applications due to their excellent capability for specific regioselective reactions in a variety of organic solvents with broad substrate recognition.

Diagnostic enzymes

Peroxidase, Alkaline phosphatase, uricase, beta-glucosidase, luciferase, ornithine decarboxylase, glucose oxidase, uricase are some of the enzymes used for diagnostic and analytical purposes. Most such enzymes are currently imported in India with the exception of few enzymes for cloning that are made by couple of companies.

Amino acids and Vitamins.

Most amino acids are made via fermentation process. Japan is a leader in this industry; however, China is rapidly taking over this area. India makes few amino acids but its demand is increasing and thus much potential exist for developing this industry at a large scale. Many vitamins including biotin are being produced via fermentation process, in addition to direct purification of natural vitamins as well as chemical synthesis.

11.2 Marine Products

Shrimps: Bengal State Government formed an alliance with a German firm for Rs 20 crore investment for Shrimp farming project. Meen Dweep, an island near Haldia became a shrimp and prawn zone. According to the McKinsey report, which has identified aquaculture, as an area thrust for West Bengal. Once implemented it will produce 5,000 ton of different varieties of shrimp and prawn and will generate more than 5,000 direct employment. Scientific shrimp farming was taken up in Karnataka State in early 90's. About 4,200 ha of brackish water in Uttara Kannada, Udupi and Dakshina Kannada districts were found suitable for shrimp farming.

An Indo-Spanish joint venture, India's seafood export sector addlaunched a cryogenic freezing facility in Cochin. Abad Exim Ltd. group has installed a large cryogenic freezing facility in India. The equipment for this facility has been supplied by USA. This system uses CO₂ for quick-freezing to retain the purity and texture of the product. Abad group has been in the forefront of the Indian seafood sector with emphasis on R & D. It has installed the first Frigoscandia IQF freezer, the first palletized and air conditioned factory. The first palletized computer controlled public cold store and now the first cryogenic freezing facility in India. With the addition of this facility, ABAD group has 11 seafood processing factories in Kerala with a combined freezing capacity of 250 Mt. per day.

Chitin, Chitosan, Glucosamine and Beta-carotene: Shrimp industry produces significant amount of waste. Chemchito Natural Products is the first company to manufacture Chitin and Chitosan from Shrimp waste in India. The company was started in 1989 and later started manufacturing Glucosamine hydrochloride and Sulphate. The Company has the capacity to produce 15 MT/month of Chitin from which they possess 5MT/month of Chitosan and 3MT/month of Glucosamine Sulphate.

A chain of small chitin plants spread over the entire Eastern Coast of India, wherein they process chitin very close to the place where shells are available. Then chitin is brought to the chitosan and glucosamine plants. These are India's Exporters of this marine by-product to USA and Europe. The potential to grow this industry is, however, much larger than has been realized, including making dozens of other byproducts from chitin and extracting beta carotin from shrimp before processing for chitin production. The chitin production itself generates protein hydrolyzates that need to be captured and recycled for animal feed. Unlike animal by products from slaughterhouses, marine by-products can be mixed with animal feed of the lactating animals.

Fish Gelatin: Isinglass is a very pure transparent gelatin obtained from the swim bladder of certain fish, especially sturgeon. It is used for making jellies and especially as a fining agent to clarify wine. It has been mostly replaced by animal gelatin but still needed for analytical use. Isinglass collagen is one of the purest forms of protein collagen occurring in nature, and for all practical purposes may be considered as 100% collagen. Isinglass collagen can be easily solubilised in dilute acids, without any pre-treatment or physical disruption

and yet remains stable as a finings for many weeks under normal conditions. Isinglass contains 93-98% of the total collagen present in an easily soluble form. Chemofine Enterprises is a Bangalore based manufacturer & exporter of Isinglass finings, established in 1983 as a manufacturing unit.

Agar, Agarose, and other Marine Phytoproducts: Almost 200 species of seaweed are being harvested commercially. Of these, 145 species are used for food and 110 for phycocolloid production (eg. agar). Agar-agar, agarose and carrageenan are commercially valuable substances extracted from red seaweeds. Agar is used extensively in food preparation and in the pharmaceutical industry as a laxative or as an outer cover of capsules. Carrageenans are generally employed in gelation (in foods like ice cream), viscous behaviour and stabilization. They are also used in lipsticks, soaps, film, paint, varnish and buttons. In addition, gums including, carrageenan and alginate from seaweeds can be prepared.

According to the Food and Agriculture Organisation (FAO), global production of aquatic plants rose from 3 million tons to nearly 10 million tons (wet weight) between 1981 and 2000. The seaweeds trade raked in US \$250 million in 1990, while in year 2000 the seaweed trade rose to US \$6 billion. The contribution of cultured seaweeds in 2000 was 15% of total global aquaculture volume (46M Tons) or nearly 5% of total volume of world fisheries production (141M Tons). China holds the first rank in production followed by North and South Korea, Japan, Philippines, Chile, Norway, Indonesia, and USA. India with over 2000 km of costal line plays a very small roll in this industry. Even for Agar production, much of the red seaweed is being imported from Spain. If cultivated and managed properly, this industry can bloom in India. The seaweed industry in India is mainly a cottage industry based only on the natural stock of agar-yielding red seaweeds, such as *Gelidiella acerosa*, *Gracilaria edulis*, and algin-yielding brown seaweeds species such as *Sargassum* and *Tubineria*. The production of seaweeds (all categories) in India in 2000 was approximately 600,000 Tons (wet weight). India produces 110-135 Tons of dry agar annually utilizing about 880-1100 Tons of dry agarophytes. Annual algin production is 360 to 540 Tons from 3,600 to 5,400 Tons dry alginophytes. This industry can grow 10 times and be internationally competitive, if it is organized properly and utilize state-of-the-art technologies for the production of Agar. Further conversion of Agar in to Agarose and

agarose products (Agarose beads (Sephacrose) can add significant value to this industry.

11.3 Other Bioresources

Feathers and Hair (L-cysteine) – This important amino acid is produced commercially from animal and human hair and feathers. When produced from animal hair it is almost certain that all L-cysteine is taken from slaughtered animals. When human hair is used it is often sourced from people in Asia. L-cysteine is used as an additive in around 5% of bread and other bakery products. It is not used in whole meal bread or other whole meal bakery products. The global market of cysteine is over \$200M/ year. India has a significant potential to produce L-Cystine as there is plenty of supply of human hair is available. Technology for this will have to be imported from Japan.

Urine(urokinase and conjugated estrogens): Urine seems like an undesirable waste product of the body, but to the medical research community and the drug industry it's been considered as a liquid gold. Realizing its potential an enterprising company in Michigan has come up with a way to trap medically powerful proteins from urine. Enzymes of America has designed a special filter that collects important urine proteins, and these filters have been installed in all of the men's urinals in the 10,000 portable outhouses owned by the Porta-John company, a subsidiary of Enzymes of America. There is a \$600-million/year market for these kinds of urine ingredients. Enzymes of America is marketing its first major urine product called urokinase, an enzyme that dissolves blood clots and is used to treat victims of heart attacks. The company supplies the urine enzyme to Sandoz, Merrell Dow and other major pharmaceutical companies. The 14 million gallons urine flowing annually into Porta-John's privies contain about four-and-a-half pounds of urokinase able to treat 260,000 patients. China is purifying conjugated estrogens from equine urine for medicinal use. Even as a liquid fertilizer it has value which needs to be captured by the dairy farmers.

Microbial Biocides and Phytoinsecticides: Biocides are fast growing products to control plant pathogens, plant insects, nematodes etc. and are attracting significant attention. Plant-derived or bacterial derived insecticides, bacteriosides and other hygienic products, are difficult to produce in large quantities. Phytoinsecticides offers a great product for India and India can produce such products very

economically for the export market. Some efforts are currently being made by few companies primarily focusing on Neem derived products, but there are many other plants that produce valuable phytoinsecticides and such plants can be cultivated and processed. A recent study showed the effects of *Stemona tuberosa* and *Acorus calamus* ethanol extracts on the Diamondback Moth, *Plutella xylostella* (Linnaeus). It was found that these extracts have the best activity against third-instar larvae of *P. xylostella*. This industry needs to be developed further supported by basic research, formulations and marketing efforts.

Microbial Media: The global requirement of microbiological media (including India) is very significant ranging from \$200-400M and the major players in this industry are BDH, Sigma, EMD and other speciality media suppliers. India has made a good beginning in this area and HiMedia, Bombay, and Marine Chemicals, Kochin, are producing good quality microbial media for national consumption with some export, but the quality needs to be further improved in order to compete internationally in this area. Since microbial media has both plant-derived and animal-derived products, the potential for India in this area is significant.

11.4 Biorefineries

Current agricultural residues, molasses and energy crops all serve as feedstocks for the emerging biorefineries. In the Biorefinery, biomass or components of biomass is processed and fractionated into its component parts. Cellulose and hemicelluloses from biomass can be converted in to value added products. By far the biggest application for cellulose and hemicelluloses fraction is in the production of biofuels. While ethanol has been the current focus, it is important to realize that more advance biofuels such as butanol and isobutanol, octanes are being produced by deploying the tools of synthetic biology. These advanced biofuels have superior properties in relation to ethanol and also augment the efficiency of ethanol in the fuel systems. The Indian Government should encourage the development of this industry since it is an important mechanism to reduce the country's dependence on imported fuels as well as create higher value for the byproducts in the food and feed stream.

Cellulosic Ethanol: There are at least two methods of production of cellulosic ethanol; ethanol enzymatic hydrolysis and fermentation. The technology has now reached the stage

where companies are now manufacturing complete turnkey cellulosic ethanol plants. One such plant in Georgia, USA is under construction where a plantation of 20,000 acres of *Paulownia* is expected to produce ethanol for export to Europe. The cellulose molecules are composed of long chains of beta-glucose molecules. In the hydrolysis process, these chains are broken down to sugar before feeding it to a fermentor for alcohol production

Cellulosic ethanol is obtained from cellulose, the main component of wood, straw and much of the plants is cheaper. The price per ton of raw material is much lower than grains and fruits. Moreover, since cellulose is the main component of *Paulownia* (see below), the whole plant can be harvested and used. This results in much better yields per ha

According to US Department of Energy (DOE) studies conducted by Argonne Laboratories, one of the benefits of cellulosic ethanol is that it reduces greenhouse gas emissions (GHG) by 85% in reformulated petrol. By contrast, sugar-fermented ethanol reduces GHG emissions by 18% to 29% over petrol. Recent improvements in biofuels technologies are emphasizing the importance of butanol fermentation which provides more BTU per unit input. Butanol was initially produced during early 1940's but as the cost of corn feed grew, this technology was no longer found to be economical.

- For ethanol, all investments in cellulosic ethanol production must be given full tax credit for 5 years based on the actual amounts of ethanol produced starting from plantation to production.
- India has been importing ethanol for the last 6 years and allowing blending of ethanol in petrol would require 610 Million liters of ethanol per year, a capacity which is not available in India at present.

Contrary to common belief that massive subsidies are needed to promote bio-ethanol, it is now price-competitive with petrol (gasoline) in India without subsidies, due to recently skyrocketing petrol prices. This is the case even after adjusting for energy-equivalency (one liter of petrol has the same energy content as 1.5 liters of ethanol). India is targeting a 10% blend of ethanol in its national petrol supply. Grain (corn and wheat) produced alcohol is clearly not suitable in India, so the choices are sugarcane, sorghum and lignocellulosic biomass. The constraint is not the cost of ethanol production; it is the supply of raw materials to support the production of biofuels.

Most of the ethanol in India is currently being produced from molasses and over 100 small refineries are producing small quantities of ethanol. This quantity is clearly not sufficient to meet even the chemicals production demand let aside the petroleum-mixing demand of the country. Certainly under no circumstances food grains can be used for ethanol production in India as it is being done in many other countries such as USA where corn is the major source of biofeed for ethanol industries. Brazil produces ethanol from sugarcane but uses direct sugarcane juice and not much molasses. Sugarcane productivity in Brazil is almost 25% higher and the sugar yield is 34% higher, making the cost of producing ethanol almost 50% cheaper in Brazil. Currently Brazil produces 42% of the World ethanol while US is number two producing 37% of ethanol. With the rapidly increasing capacity for not only corn-based ethanol production but also lignocellulose-based ethanol production, US will become number one in ethanol production in just next 3 years time.

The sugarcane industry in Brazil has the potential to be an important contributor to the growth of secondary agriculture industries – it is important that India invests in development of modern technologies to both improve agricultural productivity and processing efficiency of this important crop. The emphasis should not be on expanding the land under cane cultivation – it should be about getting most from existing land and leveraging state of art machinery for processing the crop, storing and distributing the raw materials and end products.

11.4a *Paulownia* Plantation

Paulownia is a true miracleplant and is referred as the fastest growing tree in the World. It has been cultivated as plantations for more than 3,000 years in China. Besides an excellent source of wood, it can produce significant amount of cellulose for the biorefinery industries. Although the wood is light in weight, it is very strong. It has low shrinkage coefficient, high strength-to-weight ratios, high heat insulation and low temperature conductivity properties, and has high absorption rates for glue, paint and dyes.

In China and Japan, *Paulownia* wood is used in house construction for roof beams and purlins, due to its light weight and resistance to sagging. It is used for doors, windows, partition boards, ceilings and inner roofs, because of its resistance to warping. *Paulownia* makes excellent, high-grade plywood as it is lightweight, easy to slice, knot free and has good glue holding properties.

Non-wood uses of Paulownia include: high protein animal feeds made from the foliage, medicines are made from the leaves, fruits and stems. A solution, prepared from the leaves and fruit, is said to promote healthy hair growth, and turn gray hair black, while still another solution relieves swollen feet. Thus, this multipurpose non-invasive tree cannot only create a whole new cellulosic biofuel industry but also will create many secondary agriculture related jobs. It is already under cultivation in many parts of India but no systematic plantation and harvesting is available. This single species, if propagated via tissue, culture, planted, harvested and used as a feed for biofuel can have a major ecological and economic impact. The global demand for the plantation material is so high that India can play a major role in supplying the *Paulownia* saplings internationally.

Recent realization that grain-produced ethanol may not be sustainable as it is increasing the price of all food grain, attention is shifting to alternate source of biofeed, In that *Paulownia* lignocellulosic biomass comes out as a significant player.

One hectare (ha) of paulownia trees can produce 32,000kg of fresh palletized fodder or 11,600 kg of dried palletized fodder in just one year. In year two, after the crop has been thinned down to 2000 trees per ha. A biomass of 16,000 kgs can be generated for ethanol production. Alternatively, rather than using the biomass in the first year as fodder it can be used in the "cellulosic ethanol generator". This is the most significant technology in our times in relation to the production of sustainable energy, the cellulosic ethanol/butanol, and India can develop this process. High quality timber could be obtained from the plant in six years, and it could be grown on plains and mountainous regions up to a height of 2000 meters under Indian conditions. In the northern plains of the country, the growth starts with the onset of spring and continues till the beginning of winter. The tree yields nearly 30 to 35 cubic feet of quality, merchantable rough-sawn timber and can be harvested up to six to seven times. With the implementation of proper Paulownia plantation management models, it is possible to generate significant income streams for farmers and solve energy problem as well as capture Carbon credits.

This fast-growing plant of Chinese origin, Paulownia, is set to replace other wood being used for timber, like poplar and eucalyptus, by projecting itself as a wood that can not only be used for furniture purposes, but also as

lignocellulosic biomass for biofuel production. Farmers are likely to get a much higher remuneration than from it than through other forestry means. The plant makes an excellent agro-forestry tree that can be inter-cropped with wheat, maize, groundnut, soybean, millet, gram, vegetables, tea and coffee. The plant can be propagated from cuttings and tissue culture techniques. So far only about 1.5 lakh tissue cultured plants have been transferred to the field in both northern and southern states of India.

Though the plant has been grown on an experimental basis by only a few progressive farmers in India since the past few years. Having been cloned for Indian conditions by the Tatas, the plant is slowly making its presence felt in Punjab. Recently he went in for more cultivation of the plant as he felt its growth was faster than that of poplar. Recently, it is realized that this tree is an excellent source of lignocellulosic biomass for biofuel production.

Increased production of paulownia would not impact the ecology in the same way as growing eucalyptus, which drives away bird life and reduces the quality of the soil and consumes more water. Paulownia also grows much faster. Growing this tree not only creates income for farmers, it also builds better environmental conditions reducing pollution.

Economic and Social Benefits of Paulownia crop: Grown widely in China, Australia, Taiwan, the US, Brazil, Argentina, Paraguay, Thailand, Indonesia and South Africa, Paulownia is relatively new to Indian soil. At present in China, intercropping with Paulownia is being carried out on some 1,300,000 hectares of land throughout the whole country and well over 1.3 billion trees have been planted. Plantation programs have also been established in North America, South America, Central America, New Zealand and Australia. A company, TroPaul™ (Tropical Paulownia Tree Farms, Ltd.) represents an composite of corporations and individuals, engaged in the production of *Paulownia* trees in the Tropics, specifically for the manufacturing of high-grade, hardwood, plywood with potential of biofuel.

Almost 17,000 Acres of under utilized agricultural lands is being planted in each production unit of this new, management/labor relationship. Once the mill goes into production, about 20 percent of the jobs will be in tree production, and the remainder in the harvesting and mill operations. In addition, many indirect jobs will be created in the associated supply and shipping industries, thereby adding to the overall social and

economic status of the rural sector. On the Japanese market the paulownia wood is worth US\$800 per cubic meter.

Paulownia can be micro propagated successfully: This deciduous tree responds extremely well to high levels of sunlight. Of the nine species, *P. fortunei* and *P. elongata* are known to grow well in tropical and sub-tropical climates. An estimated 6 million acres is under Paulownia cultivation worldwide. The plant can be propagated through cutting or in tissue culture.

The tree reaches a phenomenal height of 16 to 18 feet in the first growing season, which is approximately about 12 months. This spurt in growth is followed by a period of dormancy with the onset of winter. The growing season resumes with the beginning of spring. Dr. Barathi (Thailand) said in well-managed plantations, the tree grew to a height of 35 feet in eight years, achieving a yield of more than 35 cubic feet of good quality timber fetching on an average Rs 8,750 per tree. said the tree could be planted as a woody inter-crop with wheat, maize, groundnut, millet, grams, cotton, vegetables, tea, coffee, cardamom and other plantation crops for the first 2 years of growth. Studies have shown that the leaves absorbed noxious industrial gases like sulfur dioxide and nitrous oxide.

In India, Paulownia is currently grown from the Terai region of UP through Assam in the East and Hoskote in the Deccan Plateau to Coimbatore, Dindigul and Kovilpatti.



Figure 11: Propagation of Paulownia from cuttings using drip-irrigation system to conserve water.

1. The tree is fast growing and can be harvested in 5-6 years.
2. The key benefit is that the Paulownia tree is coppice which means that the same tree can be harvested 5 to 7 times. After

harvesting, a new coppice Paulownia tree grows back from the stump and uses the same well-established root system to provide vigorous growth.

3. Paulownia wood is fire resistant (ignition temperature is 400°C plus) and water repellent.
4. It has multiple uses for commercial applications.
5. **Carbon Credits** can be measured and obtained from the large plantation and traded for another source of income.
6. More importantly the leaves and branches from the trees can be used to manufacture ethanol.



Figure 12: A Paulownia plantation showing that inter-cropping can be done with this forest crop increasing the sustainability of farmer during the time when crop matures. Commercial paulownia plantations are now located in tropical regions of Thailand, Australia, USA. The photo above depicts a Paulownia plantation in Loei, Thailand and a company is growing these plants in India at Tamil Nadu.

For more information of this fast growing tree for wood and biofuel production see: <http://www.cropdevelopment.org/paulownia/Brochure.pdf>

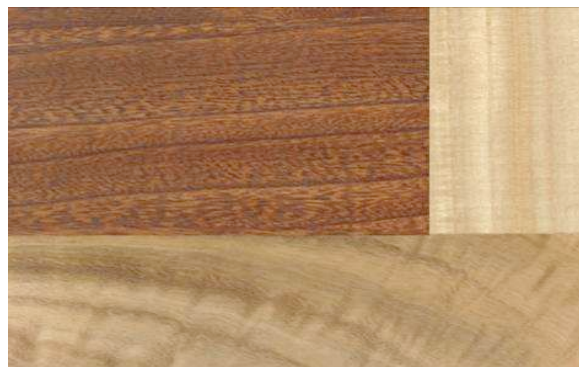


Figure 13: High-value Paulownia wood for furniture and plywood manufacturing

Besides traditional construction lumber, plywood, veneer, products such as gift boxes, toys, handicrafts, ship building and agarbathi sticks can be made from this wood. The wood is highly rot resistant and contains very low level of extractives causing no stains and scars on the finished wood.

Developing nations are looking towards biofuels to help reduce their spiraling foreign oil import costs, and to mitigate pollution and global warming. The dry lands, often neglected can contribute importantly to a bio-fueled future.

Indian Farm Forestry Development Co-operative Ltd. (IFFCO) is a Multi-State Co-operative established in 1984. IFFCO is visualized to become a model for large-scale adoption for forestation on wasteland and Rural development. This is to be achieved by promoting village level Primary Farm Forestry Co-operative Societies (PFFCS) for socio-economic development of the landless, marginal & small farmers, particularly women. IFFDC is presently working in all Indian Union. More than 26000 ha. of wasteland comprising sodic, ravines, waterlogged and hilly areas have been converted into green forest through 145 village level PFFCS having a membership of 28,500 out of which 38% are landless and 51 % fall under marginal and small category. Special emphasis has been laid on women participation who represent 30% of the total membership. IFFDC membership is open to Indian Farmer Fertilisers Co-operative Ltd. (IFFCO), National Co-operative Development Corporation (NCDC), Primary Farm Forestry Co-operative Societies (PFFCS), State Farm Forestry Co-operative Societies (SFFCS), Government of India, and any other co-operative institution or corporate body owned or controlled by the Government having an interest in the promotion of the

Forestry Activities. As of 2005, 147 PFFCS Societies and 22 PLDCS Societies are members of IFFDC. The real impact of this organization will depend upon the scale of self sustainable projects it can support.

If IFFCO adopts Paulownia & Pangomia Plantation Project described in this report, it would have a significant impact on forest development by supporting a variety of secondary agriculture industries and support the livelihoods of millions of rural people. Additional Government support needs to be made available for this project on self-sustainable basis.

11.4b Jatropha

The Biofuel industry has received significant attention in recent years and has been a subject of much debate. In particular emphasis has been placed in India on Jatropha plantation based on several assumptions. However, some of these assumptions are not holding true as was revealed by a workshop organized by the Planning Commission and TACSA (see Appendix).

The economics of Jatropha oil production is not well worked out since it is based on several assumptions. The first assumption is that Jatropha grows on marginal soils and does not need much water. Infact the growth and productivity of Jatropha plants is proportional to the availability of nitrogen and water which in turn increases the cost of productivity of this crop. Oil is obtained from jatropha seeds and the farmers need to get at least Rs.4 to 5/ per kg of jatropha seed to make the agriculture economics for cultivation of jatropha workable. It would be possible to produce transesterified oil at cost below Rs.25/- per liter only if the price of the seed would be less than Rs.4/- per kg. At prices higher than that, jatropha cultivation would be a losing proposition for the farmers. The workshop organized by PC on the request by TACSA on Jatropha cultivation and processing in the country (Feb 1, 2008) showed that the viability of this crop for sustainable oil production is questionable and even the oil industries involved in this project acknowledged that it is a long term proposition, at best. There were 3 Technical Sessions namely, i) Research and Development Scenarios in Biofuel, (ii) Environment and Toxicity Impacts and (iii) Production Strategies and Quality Improvement and Processing Economics and Marketing (See Appendix).

The cake produced after extracting oil from Jatropha seed cannot be used as cattle feed, as

in other parts of the world where the vegetable oil for bio diesel production are produced from edible crops such as rape seed and soya. *Jatropha* is a non edible crop and the seeds are toxic. The utilization of the cake is very important for optimizing the cost of production of *jatropha* oil. As of now, there is no plan for use of the *jatropha* seed cake arising after oil extraction. The one possible solution is to use the cake as biomass for production of power. But, no worthwhile pilot plant studies have so far been undertaken to assess the process parameters and the economics of operations for such a biomass unit. The genetic variability in *Jatropha* is significant and potential exist for identifying toxin-free and high oil yielding varieties to increase its income-earning potential.

For mixing with diesel, the raw *jatropha* vegetable oil has to be transesterified. The process of transesterification involves the production of glycerin as co product, at the rate of 250 kgs of glycerin for every 1000 kg. of transesterified oil produced. The Indian demand for glycerin at present is only around 50,000 tons per annum and large production of transesterified oil would lead to substantial surplus production of glycerin in the country. There is no way to sell the surplus quantity of glycerin which is already produced in sufficient quantity in the country. In view of the huge capacity creation for biodiesel in Europe and North America in recent times, glycerin has become a surplus commodity in the world offering new opportunities to convert this byproduct in to more valuable products. At USDA glycerol has been used as a fermentation substrate for the production of biodegradable "value-added" materials, such as synthesis of microbial-derived biopolyesters (i.e., polyhydroxyalkanoates; PHAs) and biosurfactants (i.e., sophorolipids; SLs). It has been determined that both short-chain and medium-chain PHA with widely varying properties can be produced from crude glycerol by different strains of *Pseudomonas*.

A dynamic initiative to work on glycerin-based research is necessary to take the biodiesel programme forward. The National Chemical Laboratory in Pune needs to focus on such important developments that can have wide implications for the country.

The economic and viable capacity for the trans esterification plant for producing trans esterified oil from *jatropha* vegetable oil is estimated to be 30,000 tons per annum which would call for investment of several crores of rupees. The trans esterification project is a medium or large-

scale industry and is not a small scale operation.

While a number of trans esterification plants of large size of one million tones per annum are in operation abroad, none of them are based on *jatropha* oil but on other crops such as soya or rape seed etc. At present there is no commercial experience anywhere in the world in operating large scale trans-esterification plants based on *jatropha*. The net result of this situation could be import of trans esterified oil from overseas countries to India in the coming years, which would leave the Indian *jatropha* industry very vulnerable.

11.4c Sweet Sorghum

The potential of a little-known dry land crop, sweet sorghum, to help fill the supply gap for raw material for biorefineries is exciting as it will add significant value for the farmer. 'Sweet' varieties of sorghum store sugar in their stalks, while also producing reasonable grain yields.

Sorghum, like sugarcane and maize, exhibits C4 metabolism – making it more efficient at converting atmospheric carbon dioxide into sugar than most plants. As a dry land crop, sorghum requires far less water than costly irrigated sugarcane, making it more accessible to the poor. The juice squeezed out of sweet sorghum stalks contains about 15-20% sugar that can be fermented into ethanol more cheaply than from sugarcane molasses—and with even greater energy savings compared to maize grain, which has to be hydrated and converted from starch to sugar before it can be fermented. ICRISAT is stimulating public-private collaboration to move sweet sorghum from a good idea on the shelf, to impact on the ground. The hybrid sorghum program receives substantial support from the private sector (30 seed companies) through an innovative Hybrid Seed Consortium.

ICRISAT also formed a public-private partnership with Rusni Distilleries (P) Ltd. Rusni ensures that seeds of the highest-sugar sorghum varieties identified by ICRISAT and NRCS reach farmers so they can increase their productivity. Rusni also helps farmers by transporting the stalks from farms within a 30 kilometer radius of the plant, and providing more distant farmers with technologies to crush the stalks and reduce the juice into syrup that can be moved cost-efficiently to the ethanol production plant. Lessons learned from this partnership will enable the technology to scale up faster and more widely in the coming years.

India's National Research Centre for Sorghum

(NRCS) has long recognized the potential of sweet sorghum and has developed excellent open-pollinated varieties and some hybrids. The major contribution has been the identification of high-sugar parent lines for hybrid breeding from global germplasm collection. Hybrids are also less photoperiod sensitive so they can be grown year-round, smoothing out supply variations for the ethanol production facilities. Sorghum production in India has been declining for many years due to subsidies for rice and wheat, lessening economic opportunities for dryland agriculturalists.

Transition the sorghum enterprise from a human food to a cash crop for bio-ethanol as well as

producing grains and stalks that feed livestock is the right step to take. This can help rural people gain greater self-sufficiency in energy production through bio-diesel crops. The benefits are multiple and significant: easing poverty, reducing air pollution, mitigating global warming, and rehabilitating degraded wastelands.

Two contrasting dry land species have received some attention: *Pongamia pinnata*, a leguminous tree adapted to wetter wastelands with problem soils; and *Jatropha curcas*, a more drought-tolerant shrub adapted to well-drained wastelands. Both produce fruits containing about 35% oil suitable for bio-diesel.

12

MARKETING OF AGRO-BASED PRODUCTS

In today's economy marketing plays a very important role in the success of any product and its associated business. Agriculture primary produce and secondary products are no exception. Farmers in India have very little resource for marketing any product they produce. The food-related secondary agro-products are increasing in demand and associated industries are growing using traditional marketing channels.

12.1 National Markets

An Inter-Ministerial Task Force on Agricultural Marketing Reforms suggested several measures for strengthening agricultural marketing system in the country. A report was prepared in 2002, that addressed benefits to farmers from the new global market opportunities, the competition among the market players and to enhance the share of farmers in the final price of their agricultural produce. This profile was prepared with a view to enable the farming community to scientifically manage the post-harvest operations in respect of paddy/rice crop in order to realize higher price in the market. The profile covers almost all aspects of the marketing which include post-harvest management, marketing practices, standards and quality, grading, packaging, transportation, storage, sanitary and phyto-sanitary (SPS) requirements, etc.

Twelve Agro Economic Research (AER) Centers were formed across India. During 2005-06, about 45 studies were completed by these centers and during 2006-07, another 40-45 research studies were proposed. These studies directly relate to various economic problems in agriculture, animal husbandry, water management and allied areas. However, the real impact of these reports yet to be felt by the farmers for whom these Centers were established and studies are commissioned.

The following profile was presented by Mr. B. K. Joshi, Marketing Officer under the supervision of B.D. Shekar, Dy. Agricultural Marketing Adviser, Nagpur.

12.1a Traditional Marketing

The agricultural marketing system in India operates primarily according to the supply and demand in the private sector. Indian Government intervention is limited to protecting the interests of producers as well as consumers and promoting organized marketing of agricultural commodities. In 1991 there were 6,640 regulated markets to which the central government provided assistance in the establishment of infrastructure and in setting up rural warehouses. Various central government organizations are involved in agricultural marketing, including the Commission for Agricultural Costs and Prices, FCI, CCI and JCI. There are also specialized marketing boards for rubber, coffee, tea, tobacco, spices, coconut, oilseeds, vegetable oil, and horticulture products.

A network of cooperatives at the local, state, and national levels assist in agricultural marketing in India. The major commodities addressed by these organizations are: food grains, jute, cotton, sugar, milk, and areca nuts. Established in 1958, the National Agricultural Cooperative Marketing Federation of India handles much of the domestic and most of the export marketing for its member organizations.

Large enterprises, such as cooperative of Indian sugar factories, spinning mills, and solvent-extraction plants mostly handle their own marketing operations independently. Medium- and small-size enterprises, such as rice mills, oil mills, cotton ginning and pressing units, and jute bailing units, are mostly affiliated with respective cooperative marketing societies. A new

perspective in rural and agriculture marketing is recently provided by Ramakrishan (2008).

12.1b National Agricultural Cooperative Marketing Federation of India

The National Agriculture Cooperative Marketing Federation (NAFED) is the national-level organization of agricultural marketing cooperatives. NAFED achieved a turnover of Rs. 6381 crores in 2006 and Recorded a meager profit of only Rs. 1.7 crores. This operation is clearly too small with share capital of only about Rs.11 crores in 2007. Membership of the Federation is also very small having only 824 members. This activity needs to be expanded at least ten fold to make any visible impact on the agriculture sector. NAFED appears to be busy in too many activities with out a clear focus. It procured seeds (Mustard, Safflower, Soyabean, Sesamum, Copra, Groundnut, Sunflower seeds, Gram, Masoor and Cotton) of the value of Rs. 3578 crores under Price Support Scheme during 2006-07. NAFED also distributed chemical Fertilizers & Pesticides valuing some Rs. 96 crores in the states of Bihar, UP, Maharashtra, Chattisgarh, North Eastern and Southern States. Again, this organization needs to intervene in areas where the private sector has too much risk, such as organic fertilizers and biocides to increase farm productivity, opening new marketing channels and not actually trading commodities. Let the private sector handle the chemical fertilizers and food commodities area.

NAFED is also the nodal agency of the Government for implementation of Market Intervention Scheme for perishable commodities not covered under PSS. NAFED export Onion, another export commodity but with out any value addition. Total exports of NAFED were of only Rs. 520 crores during 2007. The agricultural commodities exported were primarily Onions (Rs. 485 crores), Potato (Rs. 1 crore), Rice (Rs. 17 crores), Groundnut Kernels (Rs. 1.5 crores), Turmeric (Rs. 1.3 crores), Red Chillies (Rs. 7.7 crores), masoor (only Rs 0.12 crores), mustard seed & mustard oil (Rs7 crores). If further value is added to these commodities the export value could increase 2-3 fold. For example, 5 products can come out of the dehydrated onions alone of much higher value than the raw onions being exported. NAFED handled various agricultural commodities valuing at Rs. 9 crores in joint venture with different cooperative organizations. Jute products and fruits & vegetables valuing Rs. 80 crores on consignment basis.

NAFED has constructed two Orange/Multi-Commodities pack houses of 500 MT capacity each with ancillary units for sorting, grading and pre-cooling at Umranala and Sausar in Chindwara (MP). Construction of warehouses of 10,000 MT capacity at Dewas (MP) & Sriganganagar (Rajasthan) is in progress. This is the type of activities that NAFED needs to focus on, leaving sales and purchase of common agriculture commodities to the private sector, unless they are for price support purpose to ensure the minimum returns to the farmer.

The main objectives of the Government's price policy for agricultural produce, aims at ensuring remunerative prices to the growers for their produce with a view to encourage higher investment and production. Towards this end, minimum support prices for major agricultural products are announced each year which are fixed after taking into account, the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP while recommending prices takes into account all important factors, such as:

- Cost of Production
- Changes in Input Prices
- Input/Output Price Parity
- Trends in Market Prices
- Inter-crop Price Parity
- Demand and Supply Situation
- Effect on Industrial Cost Structure
- Effect on General Price Level
- Effect on Cost of Living
- International Market Price Situation
- Parity between Prices Paid and Prices Received by farmers (Terms of Trade).

Of all the factors, cost of production is the most tangible factor and it takes into account all operational and fixed costs. Government organizes Price Support Scheme (PSS) of the commodities, through various public and cooperative agencies such as FCI, Cotton Corporation of India (CCI), Jute Corporation of India (JCI), National Agriculture Cooperative Marketing Federation of India Ltd. (NAFED), Tobacco Board, etc., for which the MSPs are fixed. For commodities not covered under PSS, Government also arranges for market intervention on specific request from the States for specific quantity at a mutually agreed price. The losses, if any, are borne by the Centre and State on 50:50 basis. The minimum support price policy paid rich dividends. Although the Government has raised substantially the MSPs in recent years, the net benefit to farmers has been minimal due to increased cost of production.

12.1c Cooperative Marketing

In late 1980s, there were about 2,400 agro-processing units in India in the cooperative sector. Of all the cooperative agro-processing industries, cooperative sugar factories achieved the most success. The number of licensed or registered units in 1988 was 232, of which 211 had been installed and 196 were in operation. They produced nearly 5.3 million tons of sugar, accounting for about 57 percent of the country's total production of 9.2 million tons. The National Federation of Cooperative Sugar Factories renders advice to member cooperatives on technical improvement, financial management, raw materials and inventory control. In recent years many sugar mills have closed down as this industry is running in loss and being subsidized by the Government

In the early 1990s, the cooperative marketing structure comprised 6,777 primary marketing societies: 2,759 general-purpose societies at the *mandi* (wholesale markets in India) level and 4,018 special commodities societies for oilseeds and other such commodities. There are also 161 district or central societies covering nearly all important *mandis* in the country and twenty-nine general-purpose state cooperative marketing federations.

The Indian Ministry of Agriculture's Directorate of Marketing and Inspection is responsible for administering federal statutes concerned with the marketing of agricultural produce. The directorate works closely with states to provide agricultural marketing services that constitutionally come under state purview.

Under the Agricultural Produce (Grading and Marketing) Act of 1937, more than forty primary commodities are compulsorily graded for export and voluntarily graded for internal consumption. Although the regulation of commodity markets is a function of state government, the Directorate of Marketing and Inspection provides marketing and inspection services and financial aid down to the village level to help set up commodity grading centers in selected markets. The agriculture waste generated from such centers is not in any meaningful way collected, processed and utilized.

By the 1980s, warehouses for storing agricultural produce and farm supplies played an increasing role in government price support and price control programs and in distributing farm commodities and farm supplies. Because the

public warehouses issue a receipt to the owners of stored goods on which loans can be raised, warehouses are also becoming important in agricultural finance. The Central Warehousing Corporation, an entity of the Central Government, operates warehouses at major points within its jurisdictions, and cooperatives operate warehouses in towns and villages. The growth of the warehousing system in India has resulted in a decline in weather damage to produce and in loss to rodents and other pests. These warehouses need to be privatized so that further value addition can occur to the entire chain as more processed goods can be stored in such places and distributed for further marketing.

Most agricultural produce in India is sold by farmers in the private sector to money lenders (to whom the farmer may be indebted) or to village traders. Produce might be sold at a weekly village market in the farmer's own village or in a neighboring village. If these outlets are not available, then produce might be sold at irregularly held markets in a nearby village, or in the *mandi*. Farmers also can sell to traders who come to the farm site.

The Indian government has adopted various measures to improve agricultural marketing. These steps include establishing regulated markets, constructing warehouses, grading and standardizing produce, standardizing weights and measures, and providing information on agricultural prices over All India Radio (Akashvani), the national radio network. This information needs to become more organized by providing on-line service to each village at the Panchayat level using the model of e-chaupals so that farmer becomes fully aware of current markets, as well as any information about value addition should be provided to the farmer at regular intervals using such channels. Haryana Government has taken initiative in this direction and has set up e-chaupals in villages with populations of 5,000 under the Rashtriya Sam Vikas Yojana (RSVY) for the eighth lakh people that reside in 323 villages of Sirsa district. ITC, a private company has set up e-chaupals in over 100,000 villages, primarily in South India.

12.1d The Public Food Distribution System

The government's objective of providing reasonable prices for basic food commodities is achieved through the Public Distribution System, a network of 350,000 fair-price shops that are monitored by state governments. Channeling basic food commodities through the Public Distribution System serves as a conduit for

reaching the truly needy and as a system for keeping general consumer prices in check. More than 80 percent of the supplies of grain to the Public Distribution System are provided by Punjab, Haryana, and western UP.

The Food Corporation of India (FCI) was established in 1965 as the public-sector marketing agency responsible for implementing government price policy through procurement and public distribution operations. The FCI is the sole repository of food grains reserved for the Public Distribution System. To nurture the Green Revolution, the Government of India introduced the scheme of minimum assured price of food grains which are announced well before the commencement of the crop seasons.

The FCI along with other Government agencies provide effective price assurance for wheat, paddy and coarse grains. In the last two decades, food grain procurement by Government agencies have witnessed a quantum jump from 4 million tons to over 25 million tons per annum. FCI and the State Government agencies in consultation with the concerned State Governments, establish large number of purchase centers throughout the state to facilitate purchase of food grains. Centers are located in such a manner that the farmers are not required to cover more than 10 kms to bring their produce to the nearest purchase centers of major procuring states. Price support purchases are organized in more than 12,000 centers for wheat and paddy every year in the immediately after harvest of a crop. While this extensive and effective price support operation has resulted in sustaining the minimum income of farmers, it has not encouraged or provided any incentives for value addition. Privatization of procurement and distribution system is likely to prevent losses and increase efficiency, in addition to further adding value to any surplus that exit and often wasted due to bureaucratic delays in decision making.

In India food grains are procured according to the Government-prescribed quality standards. Almost Rs. 41 B for paddy and Rs. 43 B for wheat in Punjab and Rs. 45 B for levy rice in Andhra Pradesh is paid to the farmers/millers during wheat/rice procurement season. Each year, the FCI purchases roughly 20% of India's wheat and rice production. This helps to meet the commitments of the Public Distribution System and for building pipeline of buffer stock. Food grains, primarily wheat and rice, account for between 60 and 75 percent of the corporation's total annual purchases. The

corporation has functioned effectively in providing price supports to farmers through its procurement scheme and in keeping a check on large price increases by providing food grains through the Public Distribution System. While this system has served well in the closed economy, its value and efficiency needs to be reevaluated in the open economy.

This food procurement system has become bogged down, however, by various inefficiencies, pilferages, irregularities, waste and corruption that has increased in recent years (see, www.hinduonnet.com/fline/fl1802/18020280.htm). The time has come to transfer this system of grain procurement to the private sector under the guidelines to be provided by the Government to create efficiency, prevent losses and allow development of grain processing industries to add value. For example, the surplus grain that becomes infested in godowns needs to be processed in-time to other value-added products before it is worthless and wasted which has happened many times in many places, resulting in significant losses for the Government.

At present the private companies can only be engaged as last option as per the policy guideline. The engagement of other agencies must result in a cost saving of at least 10% of the incidentals (other than taxes, statutory charges etc.) of FCI as provided at guidelines of Ministry of Food. The Central Government Undertaking, State Government Undertaking, Co-operatives and Private Companies fulfilling the eligibility criteria and willingness to undertake paddy procurement operations on behalf of FCI may contact concerned GMs (Region)/EDs (Zone) or Procurement Division, FCI Headquarters.

12.1e Market Intervention and Price Support Systems

The Department of Agriculture and Cooperation has implemented two important schemes, namely, the Price Support Scheme (PSS) and Market Intervention Scheme (MIS), through NAFED and the state-designated agencies, to assist farmers in getting remunerative prices for their produce.

PSS: The Government of India on recommendation of the CACP announces the (Minimum Support Price) MSP for each crop season i.e., Rabi and Kharif, for various agricultural commodities. NAFED acts as the central nodal agency for procurement of oilseeds-mustard seed, groundnut-in-shell, soya bean, safflower seed, sunflower seed, sesame seed, niger seed, copra, toria; and pulses –

gram, arhar (toor), urad, moong, and masoor, under the PSS. NAFED also procure cotton under the PSS with effect from 2005, in addition to the Cotton Corporation of India (CCI) on CCI pattern. The losses incurred, if any, by NAFED, are fully reimbursed by the government. Profit earned, if any, under the PSS is credited to the government account. In addition, the central government is required to pay to NAFED the service charges at the approved rate. At present, NAFED is paid service charges at the rate of 1.5 per cent for non-perishable commodities and 2.5 percent for perishable commodities. This procurement task must be carried out by the private sector as they can be more vigilant about losses and can add further value to these commodities before turning around to the consumer, creating more jobs in the process.

Due to the significantly increased production of mustard during Rabi 2005 and 2006 seasons, the rates of mustard was much below the MSP of Rs 1700 per quintal. NAFED procured a record quantity of 20.93 lakh MT of mustard valued at Rs. 3914.00 crore, at the MSP of Rs 1700 per quintal during Rabi 2005; and 22.05 lakh MT mustard valued at Rs 4214.00 crore at the MSP of Rs 1715 per quintal during Rabi 2006. Besides mustard, NAFED also procured 66,670 MT of other oilseeds, namely, safflower seed, copra, sunflower seed, groundnut and sesame valued at Rs 144.37 crore.

MIS: This scheme is implemented at the request of State Government/UT administration. The losses are shared between the Central Government and the State Governments/UT administration concerned as per the guidelines laid down under the scheme. During 2006-07, at the request of the State Government of Rajasthan, Uttaranchal and Mizoram, the MIS for procurement of 9,250 MTs of onions, apples and chillies valued at Rs 3.02 crore was implemented through NAFED and the state-designated agencies. Thus, the growers of onions, apples and chillies in Rajasthan, Uttaranchal and Mizoram were saved from distress sale and helped in obtaining remunerative prices for their produce. The rate of chillies in Mizoram was below the economic levels. On the request of the Government of Mizoram, 1250 MT of chilli valued at Rs 0.35 crore was purchased during 2006-07. This helped the chilli growers of Mizoram in obtaining remunerative prices for their produce. There is no reason why these basic commodities, if purchased at the market price/or minimum set price and processed for further value addition, can not fetch better returns provided these

transactions are handled by the private sector and appropriate infrastructure is made available using various Government schemes. Infact, such surplus provides opportunity for value-addition, if such facilities are available in areas where surplus crop can be produced.

Recently women in Gaurikila and Ghughuri villages of Uttar Pradesh attained self-empowerment and social entrepreneurship through cooperative farming. About 4500 women in these villages thus became economically independent by practising co-operative farming.

The women grow a variety of crops like potato, pineapple, guava, wheat, rice and even flowers. They collected Rs 2000 for farming to grow vegetables including onion, potatoes and cauliflowers with the help of labourers. After the vegetables are sold, they make payments to the labourers and retain the rest of the money.

The Women Welfare Association that has helped these women become economically independent believes that they can become examples for women in other parts of the country. Earlier banks were reluctant to give them loans. But now, "banks are more than eager to lend them money," said Dr Rajnikant, President, Human Welfare Association, Varanasi, (ANI).

12.2 International Markets

International marketing for agriculture products from India, except spices and few food items, is almost non-existent. This activity requires extensive efforts using both professional marketing agencies as well as the Indian embassies in different countries. This can only happen if high quality secondary agriculture products are manufactured with World-class packaging to attract attention. Simple marketing for agro commodities will neither generate sufficient returns nor that would be attractive to consumers. The main products that needs to be directly marketed to international consumers are:

- Pure Medicinal Herbs
- Essential Oils
- Organic Farm Produce
- BioMaterials
- Enzymes/biochemical's
- Processed Foods

Organic agriculture is being pursued in India and a National Program of Organic Products (NPOP) was launched in 2000. Its aim is mainly to create certification facilities; since its inception, 2.5

million ha (~6.2 million acres) have been certified as organic farms, providing 115,238 tons of produce by the end of 2004-05 (Gauri 2005). The organic produce is aimed largely at the export market providing significant value addition to farm produce. Similarly, organic spices, medicinal herbs, essential oils and processed food can attract much attention in the international markets.

After manufacturing, marketing is the most important aspect for the success of any product

and major companies spend up to 10% of the total projected sales on this activity. Also packaging is very important and some of the products cost more in packaging than the contents, to create appeal for the consumer. For the marketing of medicinal plants internationally, Government may consider to establish two offices, one in Europe and another in USA to co-ordinate marketing efforts in Europe and North America. The export of farm produce should continue to Africa and Middle East through established channels.

13

SECONDARY AGRICULTURE WEB-INTERFACE

During the course of this report, it was realized that an interactive comprehensive database on agriculture is needed to objectively assess potential of each agro commodity and decide where technical and financial inputs can increase the value of agriculture products. A foundation for such a platform was established www.secondaryagriculture.org

This database, features of which are outlined below would require further financial and technical support to make it an engine that can drive agriculture initiative forward in India. This initiative was discussed with Dr. Mangala Rai, DG ICAR and he is in support of this undertaking.

This portal is a compendium for Indian agriculture produce and the value-added products to facilitate the emerging agricultural activities, in addition to increasing the primary agriculture activities. Designed as a one-stop integrated platform to serve farmers, traders, consultants, policy makers, administrators, job seekers/providers and others keen to avail the potential of secondary agriculture information, the portal provides in-depth insights and information regarding commodities, statistics, policy issues, market trends, farm and processing equipments, facility sharing, job possibilities, manufacturers in addition to regularly updated agricultural related news. This is the most comprehensive agriculture platform in India to date.

The User Interface: The site has ten different modules, as shown below, each of which specifically address distinct functions. The entire database is built on an interactive platform fully searchable, upgradeable and interactive.

13.1 Primary Agriculture Commodities Database

The module on commodities classifies the whole range of agricultural and allied commodities into 9 categories. Each classified category is equipped to provide sections detailing general information about the commodity, market places, product and production information, references on related government schemes and other projects, information on research institutions and the listing of products and byproducts besides a relevant agricultural directory, as follows:

Table 20: Agriculture commodities categorized under different categories

No.	Category	Number of Commodities
1	Agriculture & Fisheries	20
2	Animal Husbandry	15
3	Biomass	4
4	Cereals	31
5	Horticulture Crops	222
6	Oil Crops	26
7	Pulses	30
8	Sugarcane	2
9	Spices	37
	Total	387

1. General Information about each agriculture Commodity. (387)*

This section describes the various attributes of the particular selected commodity thus providing a complete picture of that commodity. This data

needs to be further updated by scientists expert in each topic.

- i. Name
- ii. Category
- iii. Description
- iv. Varieties
- v. Climate:
- vi. Soil
- vii. Fertility
- viii. Land Layout
- ix. Seeds and cultivation
- x. Water Management
- xi. Nutrient Management
- xii. Weed Management
- xiii. Pests and their control
- xiv. Harvesting
- xv. Processing
- xvi. Yield

2. Markets (157)*

The section on agriculture markets describes the availability of a particular commodity in the specific market places. Various mandis are linked to this section.

3. Agriculture Directory (106)*

Directory of important Agriculture Offices, Information Centers, Bureaus, Development Boards, Plant Propagation and Breeding Stations or Nurseries, Laboratories, Institutes etc. are featured in this section. In addition, international links to USDA and other sites are provided.

4. Production Information (19726)*

Production information consists of the annual state wise production statistics, area of production and yield of all commodities. This data is very large and may need further organization.

5. Projects (486)*

The section on projects is the database of current and completed research and development projects on each commodity at various research institutes. A total of 486 projects from all major institutes and research centers are listed. This database can also be searched based on commodities or institute.

6. Agri Schemes (72)

Database of financial supports available under various agriculture schemes (programmes) of Central and State governments and other agencies are listed in this section. These schemes can also be searched by commodity. This area will be expanded and can be further utilized for the management of all agroresources available in the country.

13.2 Secondary Agriculture Databases

1 Research Institutes (117)*

The section on Research Institutes comprise of the database of all research institutes in specific commodities which can also be searched state by state and commodity wise, as well as type of research.

2. Products (417)*

Products derived from the commodities and the producers and manufacturers of these products are listed in this section.

3. Byproducts (8)*

By products derived from various commodities are listed in this section along with the details of the producers and manufacturers. This section needs to be expended as more information is available on various byproducts (see appendix)

***The numbers denote the total data available in the secondaryagriculture.org database at present which needs to be expanded.**

4. Agriresources

The module on Agriresources has sections on books, policy documents and production information or any other required documents indicated as follows;

5. Books

- Statistics at a Glance

- On-line Agricultural Research Data Book- 2007

6. Agri Policies

- Export Import Policies
- Agricultural Price Policy
- National Seeds Policy 2002

7. Production Information

- Food Grain Production in Indian States, 2006-07
- Crop Prospects
- Share of India vis-à-vis some selected countries in the World Production of Major Agricultural Commodities
- Net Availability of Food grains in India
- Fish Production in India
- Fertilizer Consumption per Hectare of Agricultural Land* in Selected Countries and 1999-2000
- India's Position in World Agriculture during 2001
- State Wise Area Under Fruits & Vegetables during 2000-01 as per Land Use Statistics
- Population and Agricultural Workers
- All-India Area, Production and Yield of Food grains
- Three Largest Producing States of Important Crops during 2002-03

8. Facility Sharing

This module equips the facility owners and seekers to make use of the unutilized facilities to be shared among them. For example, a person having a rice mill of 100 ton capacity processing only 10 tons daily, the rest of the resource or facility can be shared or leased for those who need such facilities. The new entrepreneurial person is in much need for such facilities to test the feasibility of any new project for value addition to agro materials.

9. Machinery Exchange

- Different used and unused agricultural machineries are listed in this module so that the farmer or the entrepreneur can buy or sell new or used machineries.

10. AgriConsultants

This module facilitates the linkages between agricultural consultants and other sections in the secondary agriculture business and related activities.

- Various agencies extending consultancy service in agriculture sector can be listed and contacted here.
- Individual consultants can enlist themselves and offer their services in a given area of expertise.
- The industries seeking help in an area can search and request for such consultancy services.

11. Farming Machines

A comprehensive database of agricultural tools and machineries in 17 different categories. An exhaustive database of all India (State wise) machine manufacturers is also incorporated.

12. Agriculture Publications

This module can display publications related to agriculture and allied activities.

A list of books, journals and other publications related to Indian agriculture are incorporated here.

13. Agriculture jobs

Agriculture job postings and resume submission area, where jobs related to agriculture can be posted by concerned companies or institutions, and agricultural candidates.

14. Agriculture News

This module provides the up-to-date agricultural news. Seamlessly updated news from leading news providers in India.

13.2a The Web portal (www.secondaryagriculture.org)

Online Resources

The website is equipped to integrate online resources currently available and can integrate new resources as they are developed.

41 agri online resources like online database and other information resources are currently listed in this module.

13.2b Administrative Interface

Admin has the provisions for broader management of the site such as, adding, editing and deleting commodities, categories, users, agri statistics, market, equipments, and manufacturers and also to manage job module. Remote data entry is possible using a specific interface as was done for entering the institutional projects.

13.3 Further Improvements in Data Base is Needed for Objective

Analysis of Agriculture Industries, Productivity and Cost of Agro-commodities

The field of agriculture production, processing, marketing and value capture requires a variety of hard data as well as analysis to make objective decisions for policy making as well as for the industry to invest in a given area. The Indian Agriculture Statistics Institute, Delhi, should take this responsibility to update and integrate a variety of data at the secondary agriculture web site for delivery to the public and policy makers. As it stands, no data on any agriculture web site is in a format that can be used for any meaningful analysis. The portal developed by TACSA for this purpose www.secondaryagriculture.com is a first step in this direction. If further improved and to address various question, this portal can serve all primary and secondary agriculture data needs of the country. TACSA recommends that this activity be followed with the help of above institute and a private company that can deliver the desired results in a cost effective manner. This system can be further extended to for the use of agriculture graduate students and extension service persons to deliver current information to the farmer (Shukla and Kumar 1995).

14

CONCLUSIONS

This exercise to explore the potential of India in building secondary agriculture industries by adding value to various agro-bio-resources and thus bring about the “second green revolution” was appreciated by all parties involved in various discussions. It unfolded the complexity of agriculture practice and showed some of the steps that must be taken if this dream is to be realized. Extensive interactions of TACSA with farmers to scientists and industrialists suggested that there is an urgent need and desire to move forward in this direction, to jump-start the almost stagnant rural economy and help bridge the gap between the rural and urban economies that is fast emerging.

Several major points were unanimously agreed upon. These are:

1. It is realized that an enormous potential exists in building bio-resource based industries for both national needs and international markets.
2. Although a variety of agriculture schemes exist to help the farm sector, food processing and secondary agriculture industries are not well supported at present, and this sector remains largely unorganized. The layers of bureaucracy and regulatory hurdles further compound this.
3. Lack of infrastructure (roads, electricity, schools, etc.) at the rural level is the single most cited concern expressed and acknowledged by almost every one who participated in this effort.
4. Lack of desired technologies and processing equipment at par with the rest of the world, coupled with poor infrastructure, was found to be a major reason why new industries are not developing in this area.
5. Insufficient funds to build any major industry based on agro-bioresource, as large

industrialists are not interested in developing this sector beyond consumer goods. Venture capital is non-existent.

Given these difficulties and the urgent need of the farmers, as well as of the nation at large to improve the rural economy, the following steps must be taken:

1. Secondary Agriculture Industries can only be developed via a close co-operation between the Government-Industry and academic institutions in a focused manner by building a group of industries in proximity where sufficient agro inputs are available. For this a mechanism is suggested to develop 3F (Federated Farmers Farms) feeding to Mega Food Parks and delivering products to the markets. The supply-chain management system needs to be more robust and transparent to benefit the farmers.
2. The proposed Food Parks must be linked to AEZs and the Secondary Agriculture Industries as they all are interdependent and in need of the same infrastructure in the rural area. The RISC Model of services can be superimposed on this development.
3. A new investment (SAIF, as a venture fund) is urgently needed to jump-start this sector in a mission mode, as suggested in this report. These funds should be considered as investment rather than subsidies.
4. The mandate of all commodity-related agriculture institutes should be re-evaluated with focus on value addition. The agriculture curricula should be changed to reflect this fact so that appropriate hands-on training can be provided to meet the needs of these emerging industries.
5. For development/transfer of suitable

technologies, an Integrated BioProcessing Technology Institute (IBTI) working in close co-operation with industry is required to facilitate not only development of new industries but also opening marketing channels of such products internationally.

6. In order to tap the full potential of medicinal and aromatic plants and herbs, a proven area of expertise in India, it is essential that all institutes working on medicinal and aromatic plants be organized under a single umbrella to focus on strict quality controls for export of medicinal plants and their products.

7. Import of used equipment for bioprocessing and licensing of new technologies. For bioprocessing, much of the needed equipment is not available in the country and without these tools one cannot make a better products. This single step alone will make a significant visible difference within a short (3 year) time and reduce the cost of building such industries.

8. Finally, all secondary agriculture industry regulations, starting from the registration of a new company, should be brought under one window and simplified. "Let this baby grow before putting weight on it's head". These industries need to be nurtured for at least a

period of 10 years.

In an open economy, if this sector is not fully developed, the needs of the society will be met by imports of such products, further depriving the farmer of value-addition to their produce and improvement in their livelihood. Several billion dollars worth of these products are currently being imported in to the country. It needs to be realized that while ultimately, the rural population has to move into other industries, they do not have the necessary skills to be absorbed in current industries where limited jobs exist. Building secondary agriculture industries in rural areas and creating jobs for the local people is the only way to address this burgeoning problem. This would allow a transition to take place in time and will eventually transform the rural economy.

There is no choice in this saga. As Gandhiji said over 60 years ago..."Gramin Udhog Badhao"; It is high time that India develops agro-based industries to improve the rural economy and strengthen the social fabric of rural India which is the backbone of the country... hope it is not too late!

"Finally, the cost of not doing may prove to be higher than the cost of doing it"

HELP RURAL INDIA SUCCEED!

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I. TACSA Members Visits and Meetings

Lucknow (September 21st - 23rd, 2007),
Agriculture Secretary and Others
CIMAP

Rice Bran Oil Plant
Banana Plantation

Punjab (September 26, 2007)
Chief Minister
Punjab Agriculture University, Ludhiana
Food Processing Center
Frozen vegetables Plant

Maharashtra (January 18th - 20th, 2008),
NCL, Pune
KanBiosys, Bifertilizer Factory
Nasik Winery
Y. C. Open University

Orissa (January 19th - 21st, 2008),
Secretary of Agriculture
Minister of Agriculture
APICOL
Patna Tribe
Agriculture School of Management,
Baleshwar
Regional Plant Resource Center,
Nayapalli

Kerala (September 25th - 29th, 2007),
Agriculture Commissioner
Coconut Board
InBiogen
(12-15th January, 2008),
Chief Minister

Uttaranchal (January 22nd - 24th, 2008),
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86. Coconut Development Board, Kochi, Kerala.

87. Commission for Agricultural Costs and Prices, New Delhi.

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c. Proceedings of the National Workshop on Jatropha

(Held by TACSA and PC on 1st February 2008 at NASC Complex, New Delhi)

A National Workshop on Jatropha sponsored by the Planning Commission, Government of India on request from TACSA was organized by the ICAR during 1st Feb., 2008 at NASC Complex, New Delhi. The workshop was inaugurated by Prof. V.L. Chopra, Member, Planning Commission, New Delhi. Participants from various SAUs, ICAR Institutes, NGOs, Industries and Ministries etc. deliberated on this issue during the workshop.

Dr. A.K. Singh, DDG (NRM), ICAR in his welcome address highlighted the significance of jatropha as a biofuel in the context of present scenario of overall production and scarcity in the country. He also gave stress on different environmental issues related to GHG emissions and advised to increase the productivity by growing jatropha in the wastelands without compromising the overall Food Security.

Prof. D.P.S. Verma, Chairman, TACSA, in his introductory remarks, highlighted the significance of inclusion of jatropha plantation in the normal cultivated areas where food crops can be grown. He expressed concerns about the environmental impact of phorbol esters of jatropha, a toxicity component in the whole production and handling.

Prof. V.L. Chopra, in his inaugural address mentioned that the research findings till date conducted at various institutions related to the management and quality parameters are not sufficient to enhance the overall Jatropha cultivation in the country. He also emphasized on the related environmental issues concerning the cultivation of Jatropha in a big way.

There were 3 Technical Sessions namely, i) Research and Development Scenarios in Biofuel, (ii) Environment and Toxicity Impacts and (iii) Production Strategies and Quality Improvement and Processing Economics and Marketing.

Technical Session I: Research and Development Scenarios in Biofuel

Prof. V.L. Chopra, Chairman

Dr. M.S. Gill, Co-Chairman

Dr. S.K. Dhyani, Director, NRCAF, Jhansi presented the highlights of the research conducted by NRCAF and different AICRP

Centers of Agro forestry located in various State Agricultural Universities. The findings of different Network projects on Genetic Improvement, Crop Management practices including pests and diseases management on Jatropha were discussed in detail.

Dr. Parmatma, Head, TNAU, Coimbatore highlighted the research activities being undertaken at University level and informed the house that more stress is being given on development of genetic resources of Jatropha for different agro-climatic regions of the country.

Technical Session II: Environment and Toxicity Impacts

Prof. D.P.S. Verma, Chairman

Dr. Arun Verma, Co-Chairman

Dr. Ganesh Kishore, Member TAC presented in detail the impact of different toxicity parameters of Jatropha on soil health and environment.

Dr. Nutan Kaushik, TERI also presented in brief the research activities conducted in TERI on environmental and toxicity related programmes. Toxins were discussed in detail and initiation of crop research activities on different aspects of environmental related issues due to jatropha cultivation was suggested.

Technical Session III: Production Strategies, Quality Improvement, Processing, Economics and Marketing.

Dr. A.K. Singh, Chairman

Dr. Sukhpal Singh - Co-Chairman

Dr. R.S. Kureel, Director, NOVOD has presented in detail the different production strategies and quality improvement programmes, conducted on different locations in the country. It was informed that NOVOD has two promotional programmes viz. Development of model plantation with superior planting material and Research Development (R&D) on Jatropha and Karanj. About 10,000 ha area has been developed under Jatropha model plantations programme. The need to develop region specific high-yielding variety was stressed in particular.

Sh. B.B. Chaudhary, IOT Ltd. and Sh. S. Singh, DIMBO Ltd. briefly highlighted the processing, economics and marketing aspects of jatropha cultivation. They were of the opinion that biodiesel is a viable business model if the right feed tech is available. Both the speakers laid stress on the proper blending of quality biofuel and also suggested to work out the cost of cultivation properly so that farming community could get benefit out of the jatropha cultivation.

The Plenary and concluding session was Chaired by Dr. J.S. Samra, CEO, NRAA and Co-Chaired by Dr.V.V.Sadamate, Advisor (Agri), Planning Commission. The reports of different technical sessions were discussed in detail and following action points were noted:

- 1) It was observed that research activities are still in progress at different SAUs, ICAR Institutes and other organizations and the findings are not sufficient to promote the jatropha cultivation on a large scale throughout the country at this stage. Hence, the research activities related to genetic improvement and crop management along with development of high-yielding, low toxicity varieties for specific locations need to be conducted for specific regions.
- 2) The impact of jatropha cultivation on environment and toxic parameters including the soil health may also be studied with standard practices to find out the overall consequences of jatropha plantation in the context of biofuel production.
- 3) The jatropha cultivation must be restricted for wastelands areas of the country. The proper cost of cultivation needs to be worked out and accordingly minimum support price should be considered for the overall benefit of the farming community.

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IV. Secondary Agriculture-Related Important Publications

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6. Biochemistry & Molecular Biology of Plants, Edited by Bob Buchanan, Wilhelm Gruissem and Russell L. Jones, Wiley March 2002
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38. Energy Plant Species - Their use and impact on environment N. El Bassam, Edited by James & James (Science Publishers), 1998
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87. The Mycota Volume X - Industrial Applications, Edited by Osiewacz, H.D., Springer, 2002
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89. Wood and Cellulosic Chemistry (second edition), Edited by David N-S Hon and Nobuo Shiraishi, CRC Press, 2000

V. List of Medicinal and Aromatic Plants Available at NRCMAP, Boriavi

Sr.No.	Botanical Name & family	Common Name	Available Seed/ Planting Material
1	<i>Abelmoschus moschatus</i> Medic. - Malvaceae [H]	E-Ambrette plant, G-Kasturi bhinda, H-Muskdana, S-Latakasturikam	Seed 350 kg
2	<i>Abrus precatorius</i> Linn.(Red) - Papilionaceae [SCI]	E-Indian Liquorice, G-Chanothi, H-Gunchi, rati, S-Gunja	50 Nos
3	<i>Acorus calamus</i> Linn.-Araceae[PH]	E-Sweet flag, G-Vaj, H-Bach, S-Bhadra	100 Nos
4	<i>Adhatoda beddomei</i> - Acanthaceae[PS]	G-Ardusi, H-Adulsa	25 Nos
5	<i>Adhatoda vasica</i> Nees.- Acanthaceae[PS]	E-Malabar Nut, G-Ardusi, H-Adulsa, S-Shwetavasa	200 Nos
6	<i>Agave vera –cruz</i> Mill.-Amaryllidaceae	E-Elephant Aloe or Grey Aloe of India	50 Nos
7	<i>Allium shoenoprasum</i> Linn. -- Liliaceae [H]	E-Chives	1000 Nos
8	<i>Aloebarbadensis</i> Mill. Liliaceae [PH,S,Arborescent]	E-Aloe, G-Kunvarpathu, H-Gheekunvar, S-Kanya	50,000 suckers
9	<i>Andrographis paniculata</i> Nees.- Acanthaceae [H]	E-The Creat, G-Kariyatu, H-Kiryat, S-Bhunimba	Seed 03 kg 1000 Nos seedlings
10	<i>Anethum sowa</i> Kurz. – Umbelliferae [H]	E-Indian Dill, G,H- Sowa, S-Ahichhatra	Seed 01 Kg
11	<i>Argyreia speciosa</i> Sweet. Or <i>A. nervosa</i> , Bojer. – Convolvulaceae [CI]	E-Elephant creeper, Woolly Morning Glory, G-Vardharo, H-Samudrasokh, S-Samudrapalaka	15 Nos Seed 250 g
12	<i>Aristolochia bracteata</i> Retz. – Aristolochiaceae [Pcl]	E-The bracteated birth wort, G,H-Kidamari, S-Dhumrapatra	15 Nos
13	<i>Artemisia annua</i> Linn. – Asteraceae [H]	E- Artemisia	50 Nos
14	<i>Asparagus adscendens</i> Willd.- Liliaceae [CI]	G- Dholi musli, H- Ujli musli	100 Nos
15	<i>Bacopa monnieri</i> (L.) Wettst. or <i>Herpestis monniera</i> (L.)H.B.& K.- Scrophulariaceae [Pr.H,moist.]	E-Thyme leaved Gratiola, G-Brahmi, S-Jala Brahmi	100 Nos
16	<i>Barleria prionitis</i> Linn. – Acanthaceae [S]	G-Pilokantasherio, H-Vajradanti, S-Pitasareya	15 Nos

Sr.No.	Botanical Name & family	Common Name	Available Seed/ Planting Material
17	<i>Basella rubra</i> Linn.- Basellaceae [PHCI]	E-Indian Spinach, G,H-Poi S-Upodika	24 Nos
18	<i>Boerhaavia diffusa</i> Linn. - Nyctaginaceae [Pr.H]	E-Spreading Hogweed, G-Satodi, H-Sant , S-Punarnava	15 Nos
19	<i>Bryophyllum calycinum</i> Salisb. - Crassulaceae [PH]	G- Panfuti, H-Zakhma haiyat	50 Nos
20	<i>Cardiospermum halicacabum</i> Linn. – Sapindaceae [Hcl]	E-Baloon vine, Heart seed,, G-Karolio, H-Kanphuti, S-Jyotishmati	Seed 300g
21	<i>Carissa carandas</i> Linn. – Apocynaceae [S]	G-Karamda, H-Karaunda, S- Karamarda	100 Nos
22	<i>Cassia angustifolia</i> Vahl. – Caesalpinaceae [S]	E- Senna, G-Mindhi aval, H-Hindisana, S-Svarnapatri	Seed 65 Kg
23	<i>Catharanthus pusillus</i> G.Don - Apocynaceae [H]	E-Periwinkle, G,H-Sadabahar, S-Sadapushpi	200 Nos
24	<i>Catharanthus roseus</i> L.-Apocyanaceae [s]	E-Periwinkle, G-Barmasi, H-Sadabahar	200 Nos
25	<i>Centella asiatica</i> Urban. - Umbelliferae [Pr.H, moist]	E-Indian Penny Wort, G-Brahmi, H-Brahma-manduki S-Mandukparni	200 Nos
26	<i>Cestrum diurnum</i> L. – Solanaceae [S]	E-Day Queen, Day Jasmine, G- Divasno Raja, H-Din ka Raja	20 Nos
27	<i>Cestrum nocturnum</i> L. – Solanaceae [S]	E-Night Jasmine, G-Rat rani, H-Rat ki Rani	20 Nos
28	<i>Chlorophytum borivillianum</i> S. & F. – Liliaceae [H]	G,H-Safed musli, S- Musali	-
29	<i>Chrysanthemum indicum</i> DC.- Asteraceae[PH]	G,S-Shevanti, H-Guldaudi,	20 Nos
30	<i>Cissus quadrangularis</i> Linn. or . <i>Vitis</i> <i>quadrangularis</i> Wall.-Vitaceae [S]	E-Bonesetter, G,H- Hadsankal, S-Vajravalli	50 Nos
31	<i>Citrus medica</i> Linn. - Rutaceae [S]	E-Adam's Apple, Citron, G-Bijoru, H-Bara nimbu, S-Matulunga	25 Nos
32	<i>Clitoria ternatea</i> Linn.- Papilionaceae [PCI]	S,H-Aparajita, G-Garni	10 Nos Seed 250g
33	<i>Coleus aromaticus</i> Benth. or <i>C.</i> <i>amboinicus</i> Lour.-Labiatae [Pr.H]	E-Indian Borage, G-Ajmain, H-Pathorchur,	50 Nos

Sr.No.	Botanical Name & family	Common Name	Available Seed/ Planting Material
		S-Pashanbhedi	
34	<i>Commiphora wightii</i> DC.-Burseraceae [S]	E-Indian bdellium, G,H-Guggal, S-Guggulu	10,000 Nos
35	<i>Convolvulus microphyllus</i> Sieb or <i>C.pluricaulis</i> Choisy or <i>C.prostratus</i> Forsk.-Convolvulaceae [pr.H]	G-Dholi Shankhaval, S-Sankhpuspi	20 Nos
36	<i>Crataeva nurvala</i> Buch.-Ham. or <i>C.magna</i> (Lour) DC.– Capparidaceae [t]	G-Vay varno, H-Barun, S- Varuna	15 Nos
37	<i>Cymbopogon flexuosus</i> Wats. – Gramineae [PG]	E-East Indian Lemongrass H-Gawati cha	80,000 (Slip)
38	<i>Cymbopogon martini</i> (Roxb.)Wats. var. motia Burk.. - Gramineae [G]	E-Palmarosa G,H-Rosha ghas	50,000 (Slip) Seed 3 kg
39	<i>Eclipta alba</i> Hassk. or <i>E. prostrata</i> Roxb or <i>E. erecta</i> - Asteraceae [H]	G-Bhangro, H –Bhringraj, S-Markava	25 Nos
40	<i>Enicostemma hyssopifolium</i> Verdoon – Gentianaceae [H]	G-Mamejvo, H-Mamijjak	150 Nos
41	<i>Grewia asiatica</i> Mast. or <i>G. subenequalis</i> DC.- Sterculiaceae[St]	G,H-Phalsa, S-Parusha	25 Nos
42	<i>Gymnema sylvestre</i> R.Br.- Asclepiadaceae [CI]	E- Small Indian Ipecacuanha, G-Mardashingi, H-Gur-mar, S-Madhunashini	50 Nos
43	<i>Holarrhena antidysenterica</i> Wall. – Apocynaceae [T]	G, H- Kadwa-Indrajau, S-Kutaja	15 Nos
44	<i>Indigofera tinctoria</i> L.-Papilionaceae [S]	E-Common Indigo, G-Gali, H-Nil, S-Nilika	Seed 100g
45	<i>Jasminum auriculatum</i> Vahl. – Oleaceae [S]	G,H-Juhi, S-Yuthika	20 Nos
46	<i>Jatropha gossypifolia</i> Linn. – Euphorbiaceae [S]	G,H- Bag Bherenda S-Dravanti	25 Nos
47	<i>Launea pinnatifida</i> Cass. or <i>L. sarmentosa</i> Alston.– Asteraceae [H]	G-Bhopathri, H-Bankau	15 Nos
48	<i>Lepidium sativum</i> Linn. – Cruciferae [H]	E-Garden Cress G-Asalio, H-Chaunsar, S-Chandrashura	Seed 125 Kg
49	<i>Lippia nodiflora</i> Mich. or <i>Phyla nodiflora</i> Greene.- Verbenaceae [CPH]	G-Ratveliyo, H-Bhuiokra, S-Jalapippali	100 Nos
50	<i>Maranta arundinacea</i> Linn. – Marantaceae [H]	E-West Indian Arrowroot, G-Ararut, H-Tikhor, S-Tavaksiri	150 Nos
51	<i>Mentha piperita</i> L.-Labiatae [H]	E-Peppermint, G,H-Pudina	25 Nos

Sr.No.	Botanical Name & family	Common Name	Available Seed/ Planting Material
52	<i>Mentha viridis</i> L.- Labiatae [H]	E-Spearmint, G,H-Pudina	25 Nos
53	<i>Operculina turpethum</i> Silva Manso- Convolvulaceae [sCl]	E-Indian Jalap, G-Nasotar, H-Nisothe, S-Trivrit	25 Nos
54	<i>Mimosa pudica</i> Linn. – Mimosaceae [s]	E-Humble plant, G-Lajamani, H,S-Lajalu	20 Nos
55	<i>Mucuna pruriens</i> Bak, or <i>M. prurita</i> Hook -Papilionaceae [Cl]	E-Common cowitch, G,H-kawach, S-Atmagupta	Seed 01 Kg
56	<i>Murraya koenigii</i> Spreng.- Rutaceae [t]	E-Curry leaf tree G.-Mitholimdo, H-Katnim , S-Kadarya	25 Nos
57	<i>Nyctanthes arbor-tristis</i> Linn.- Oleaceae [t]	E-Coral Jasmine G-Parijat, H-Harsingar S-Sephalika	100 Nos
58	<i>Ocimum basilicum</i> Linn.-Labiatae [H]	E-Sweet Basil G-Damro H-Babuitulsi, S-Manjariki	Seed 100g
59	<i>Ocimum gratissimum</i> Linn.-Labiatae[S]	E-Shrubby Basil G-Avchibavchi, H-Bantulsi, S-Ramtulsi	25 Nos Seed 200g
60	<i>Ocimum kilimandscharicum</i> Guerke.- Labiatae [s]	E-Camphor Basil G,H-Kapurtulsi S-Karpurtulasi	Seed 50g
61	<i>Ocimum sanctum</i> Linn. – Labiatae [S]	E-Sacred Basil S, G,H-Tulsi	Seed 100g
62	<i>Pedaliium murex</i> Linn. – Pedaliaceae [H]	G-Mota gokhru, H-Kadva gokhru, S-Tiktagokhru	35 Nos Seed 200g
63	<i>Piper longum</i> L-Piperaceae [Pr.S]	E-Long pepper, G-Lindi pepper, H-Pipla mul S-Pippali	500 Nos
64	<i>Piper peepuloides</i> Roxb . – Piperaceae [S]	G-Gaj pepper, H- Gaj pippali	20 Nos
65	<i>Plantago ovata</i> Forsk.Plantaginaceae [H]	E-Blond Psyllium, G-Isabgol, H-Ispaghul, S-Isadghola	Seed 70 Kg
66	<i>Plumbago zeylanica</i> L.- Plumbaginaceae [PH]	E-White flowered lead wort, G,S-Chitrak, H-Chita	20 Nos Seed 200g
67	<i>Psoralea corylifolia</i> Linn - Papilionaceae [H]	G,H-Babchi, S-Kushthanashini	

Sr.No.	Botanical Name & family	Common Name	Available Seed/ Planting Material
68	<i>Rauvolfia tetraphylla</i> L. or <i>R. canescens</i> L. or <i>R. heterophylla</i> <i>Roem. & Schult.</i> –Apocynaceae [S]	H-Bara Chandrika	250 Nos Seed 500g
69	<i>Scaveola koenigii</i> Vahl. – Goodeniaceae [S]	G,H-Bhadraksh	25 Nos
70	<i>Silybum marianum</i> Gaertn. – Compositae [H]	E-Holy Thistle, Milk Thistle	Seed 01kg
71	<i>Solanum surattense</i> Burm.f. or <i>S. xanthocarpum</i> - Schrad. & Wendl. - Solanaceae [H]	E-Yellow berried nightshade G-Bhonya ringani, H-Kateli , S-Kantkari	25 Nos
72	<i>Tecoma stans</i> H.B. & K. or <i>Bignonia</i> <i>stans</i> L. – Bignoniaceae[S]	E-Tecoma	50 Nos
73	<i>Tinospora cordifolia</i> Miers. – Menispermaceae [Cl]	E-Giloe, G-Galo H-Gulancha S-Amrita	150 Nos
74	<i>Tribulus terrestris</i> Linn -Zygophyllaceae [Pr.H]	E-Land Calthrops G-Gokhru H-Chotagokhru S-Gokshura	15 Nos Seed 200g
75	<i>Tylophora asthamatica</i> - Wight. & Arn. or <i>T. indica</i> Merrill.- Asclepiadaceae[Cl]	E-Indian Ipecacuanha G,H-Damvel, Antamul S-Shwasaghni	50 Nos
75	<i>Vetiveria zizanioides</i> Nash. Or <i>Andropogon muricatus</i> Retz. – Gramineae [PH]	E-Khuskhus G-Valo H-Khas S-Sugandhimula	1000 Nos
76	<i>Vigna unguiculata</i> Walp. subsp. <i>unguiculata</i> Verd.- Papilionaceae [Cl]	G-Kulthi H-Kulth S-Kulattha	25 Nos Seed 500g
77	<i>Vitex negundo</i> Linn. – <i>Verbenaceae</i> [S]	E-Indian Privet G-Nagod H,S-Nirgundi,	40 Nos
78	<i>Vitex trifolia</i> Linn.- <i>Verbenaceae</i> [S]	G-Safed sanbhalu H-Panikisanbhalu S-Jalanirgundi	50 Nos
79	<i>Vitis carnosia</i> Wall or <i>Cayratia trifolia</i> Domin..- Vitaceae [S]	E-Fox grape G- Khatumdu H-Amalbel S-Amlaparni	20 Nos
80	<i>Withania somnifera</i> Dunal. -Solanaceae [s]	S-Aswagandha, G-Asan, H-Asgandh	Seed 100 Kg

[G=Grass,H=Herb,S=Shrub,s=undershrub,t=small tree, T=Tree,Cl=Climber,P=Perennial,
Pr=Prostrate], [G=Gujrati, E=English, H=Hindi, S=Sanskrit]

VI. List of Projects supported by the National Medicinal Plants Board in Different States for Propagation and cultivation of Medicinal plants.

Table 1. Number of projects sanctioned for financial assistance under promotional and contractual farming schemes of the National Medicinal Plants Board (NMPB) during 2001–06

State/Union Territory	Contractual scheme		Promotional scheme		Total	
	No. of projects	Amount (in lakhs)	No. of projects	Amount (in lakhs)	No. of projects	Amount (in lakhs)
Andaman and Nicobar Islands	0	0	4	80.00	4	80.00
Andhra Pradesh	187	222.92	30	482.15	217	712.15
Arunachal Pradesh	42	194.11	18	157.50	60	344.09
Assam	2	1.81	8	91.00	10	92.81
Bihar	0	0	3	12.00	3	12.00
Chandigarh	0	0	2	25.00	2	25.00
Chhattisgarh	89	301.11	26	531.50	115	843.61
Delhi	1	1.95	22	211.20	23	213.15
Goa	0	0	3	60.00	3	60.00
Gujarat	68	105.56	19	241.50	87	347.06
Haryana	196	639.13	14	217.90	210	857.03
Himachal Pradesh	66	258.42	31	377.00	97	635.42
Jammu and Kashmir	41	100.97	23	219.00	64	319.97
Jharkhand	2	4.00	9	106.00	11	110.00
Lakshdweep	0	0	0	0	0	0
Karnataka	359	411.91	51	572.25	410	984.16
Kerala	60	81.45	33	340.20	93	431.65
Madhya Pradesh	763	1819.49	35	431.50	798	2250.99
Maharashtra	207	409.95	30	250.70	237	658.65
Manipur	164	779.20	10	124.50	174	903.70
Meghalaya	0	0	5	43.00	5	43.00
Mizoram	0	0	19	245.00	19	245.00
Nagaland	25	57.48	7	73.00	32	130.48
Orissa	138	271.66	34	488.30	172	759.96
Puducherry	0	0	1	3.00	1	3.00
Punjab	81	466.31	7	89.50	88	555.81
Rajasthan	785	2148.71	23	310.00	808	2458.71
Sikkim	32	72.20	18	355.00	50	427.20
Tamil Nadu	55	142.41	67	587.95	122	730.36
Tripura	1	8.44	5	99.00	6	107.44
Uttar Pradesh	28	94.26	49	517.30	77	611.56
Uttarakhand	117	219.04	98	1175.46	215	1394.50
West Bengal	18	47.58	23	199.30	41	246.88
Total	3527	8858.07	727	8737.71	4254	17,595.78

Table 2. Number of projects and funds sanctioned under major categories of the promotional scheme of the NMPB

Category	No. of projects sanctioned	Amount sanctioned (in lakhs)
Cultivation/herbal gardens	220	3052.10
<i>In situ</i> conservation	79	1446.40
Quality planting material	89	1377.50
Research and development	111	1295.35
Information, education and communication	192	1192.86
Marketing	26	264.30
Value addition	10	109.20
Total	727	8737.71

Grain by-products

- Vitamins
- Enzymes
- Solvents
- Animal feed
- Insecticides

Sugarcane products

- Alcohol
- Fiber Board
- Cardboard
- Paper
- Plant growth regulators

Food processing by-products

- Fruits peeling/seeds
- Soy products
- Wines
- Printing inks
- Glycerol
- Adhesives

Biomass

- Cellulose
- Xylose, glucose, lignin
- Biogas
- Fiber boards
- Bamboo & Jute

Medicinal plants

- Pure herbs
- Herbal extracts
- Phytochemicals
- Nutraceuticals

Alternative crops

- Biofuel crops
- Cosmoceutical crops
- Fluoriculture
- Horticulture
- Essential oils



Secondary Agriculture Products



**No. M-12043/03/2009-Agri.
Government of India
Planning Commission
(Agriculture Division)**

Yojana Bhavan, Sansad Marg,
New Delhi-110001, Dated: 07.06.2010

OFFICE MEMORANDUM

Subject: Screening-cum-Implementation Group (SIG) on the recommendations of
the Report on “**Secondary Agriculture: Value Addition to Primary
Agriculture**” – co-option of members – regarding

In partial modification of the Office Memorandum dated 26.02.2010, it has been decided with the approval of competent authority to co-opt the following members to SIG-TACSA committee. The composition of Group including its Chairman and Terms and Conditions of the Group will remain the same.

1. Shri. R. Gopalakrishnan,
Executive Director, Tata Sons Ltd.
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Email: rgopal@tata.com
18. Dr. P.G. Adsule Member
Director
National Research Centre for Grapes (ICAR)
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19. Shri Rakesh Bharati Mittal
Chairman, CII
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India Habitat Centre, Core 4 A
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20. Mr. Ajay S. Shriram
Chairman & Senior Managing Director,
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(S. Kesava Iyer)

Under Secretary to the Government of India

Chairman and Members/ Special Invitee of SIG

Cont..2/-

-2-

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3. PS to Member(Science), Planning Commission
4. PS to Member(Agriculture), Planning Commission
5. PS to Member(Industries), Planning Commission
6. Sr. PPS to Secretary, Planning Commission
7. Accounts-I Branch/ Admn.-I Branch, Planning Commission

(S. Kesava Iyer)

Under Secretary to the Government of India

**No. M-12043/03/2009-Agri.
Government of India
Planning Commission
(Agriculture Division)**

Yojana Bhavan, Sansad Marg,
New Delhi-110001, Dated: 26.02.2010

OFFICE MEMORANDUM

It has been decided with the approval of Competent Authority to constitute a Screening-cum-Implementation Group (SIG) on the recommendations of the Report on **“Secondary Agriculture: Value Addition to Primary Agriculture”** brought out by the Technical Advisory Committee Chaired by Prof. D.P.S. Verma. The composition of the Committee will be as follows:

- | | |
|---|-------------|
| 1. Shri Arun Maira,
Member (Industry), Planning Commission
Tel No. (Off) 23096750
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| 2. Prof. Abhijit Sen
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| 3. Dr. K. Kasturirangan
Member (Science) Planning Commission,
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| 5. Secretary
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17. Adviser (Agriculture) Convener
Planning Commission
Yojana Bhavan
New Delhi-110001
Tele Fax: 23327703
Email: sadamate1@yahoo.com

2. Terms of Reference (TOR) assigned to SIG are:
 - i) To screen the recommendations into two categories i.e. achievable targets in short-term duration and in long-term duration with a time framework.
 - ii) To identify 4-5 recommendations and modalities for their pilot testing which could be immediately taken up within the remaining 11th Plan period by the concerned Ministries/ Departments / Organizations/ Agencies and its subsequent up-scaling in 12th Plan.
 - iii) To evolve a mechanism for inter-ministerial issues by taking up National Mission for Secondary Agriculture: Value Addition to Primary Agriculture by appointing a National Project Director; and
 - iv) To suggest mechanism and modality for establishing financially and economically viable Secondary Agriculture Industries by importing the advance technologies and machineries being used in developed countries with the involvement of public and private sectors, entrepreneurs/ industries etc.
3. The Group may invite any other official/ non-official expert/ representative of any organization as member(s)/ Special invitee, if required and may devise its own procedures for conducting its business including meetings.
4. The Group may examine and address issues which are important but are not specifically spelt out in the above ToRs.
5. The Group will look & remove the bottlenecks if any, come across in achieving the desired goal.
6. The expenditure of the official Members on TA/DA in connection with the meetings of the Group will be borne by the Ministry/ Department/ State Government to which they belong. In case of non-officials, the TA/DA will be borne by the Planning Commission as admissible to the class-I officers of the Government of India.
7. Expenditure incidental to the meetings held by the Group in Delhi or outside shall be borne by the Planning Commission.
8. Screening-cum-Implementation Group will remain in force for a period of one year.
9. Dr. (Mrs.) Vandana Dwivedi, Joint Adviser (Agriculture) Room No. 230, Yojana Bhavan, New Delhi-110001 will be nodal officer in Planning Commission for this SIG for all further communications. (Tel No. 011-23096730, Fax No. 23327703 Email: dwivediv@nic.in).

(S. Kesava Iyer)
Under Secretary to the Government of India

Chairman and Members/ Special Invitee of SIG

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(S. Kesava Iyer)
Under Secretary to the Government of India